VERIFICATION AND DISSEMINATION OF OFF-SEASON ONION BULB AND ANNUAL SEED PRODUCTION TECHNOLOGY IN WESTERN HILLS OF NEPAL

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ABSTRACT

Onion (Onion cepa L.) is one of the major vegetable crops of Nepalese farmers, but a little attention on research and development works of the crop has been focused. Different onion varieties viz; Agrifound Dark Red, N-53, Red Creole, and Bemausami-1) were tested on station as well as in the farmers' field for off-season production. Among the varieties tested, the most promising variety Agrifound Dark Red was subjected to further dissemination to farmers' field in Malika, Naule Katuwal, Bijaura, Chupra and Jarkot of Dailekh district with 8-10 farmers at each site. Different parameters on onion viz; plant height, bulb length, bulb diameter, bulb weight, days to bulb harvest, fresh bulb yield, green tops yield, bulb rings, income from bulbs, income from green tops, combined income from bulbs and green tops, cost benefit ratio, seed yield and days to seed harvest were recorded. Apart from these parameters, seed quality was also assessed. The three years mean results (2008/09 to 2010/11) revealed that significant effect of sites on most of the parameters was observed except in plant height and bulb rings. Similarly, significant effect of years was observed on bulb length, bulb yield, income from bulb, income from green tops, combined income from bulbs and green tops, production cost, cost benefit ratio and seed yield excluding bulb weight, bulb diameter, days to bulb harvest, green tops yield, plant height, bulb rings and days to seed harvest. The highest off-season bulb (705.30 kg/ropani) was obtained in Malika with maximum income from off-season bulbs and green tops (Rs. 42971/ropani) and cost benefit ratio 1: 4.66. Similarly, the highest seed yield (31.67 kg/ropani) was obtained in Malika. The assessment of seed samples of the same variety showed relatively good germination and other seed quality parameters as compared to those of imported seed source from India.

Key words: Onion, off-season, fresh bulb yield, green tops, seed yield, cost benefit ratio

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops grown in the world. A global review of area and production of major vegetables shows that onion ranks second in area and third in production of the total vegetables in the world (Nashik News, 2010 and FAO, 1996). It is an important vegetable crop in Nepal based on per capita consumption, area under cultivation and number of house–holds involved in farming (Budathoki, 1997). The per capita consumption of fresh onion in Nepal is 7.7 kg which is quite lower than recommended 18.00 kg per annum. Onion is one of the important condiments widely used in all households all the year round. Onion bulb is rich in phosphorus; calcium and carbohydrates. They have been used for their medicinal properties for centuries. They have anti-bacterial and anti-fungal properties, and a paste or ointment made out of onion is said to prevent infection in wounds and burns. One amusing bit of folklore says that if you put onion juice on your head, and then sit out in the sun, you can cure baldness. Onions and all the other members of the *Allium* family are thought to have some impact on reduction of high cholesterol and blood pressure. The prudent thing for blood pressure and high cholesterol is probably to just include onions in the diet at every opportunity. Nutritive value of onion varies from variety to variety. Small sized onions are more nutritive than big ones. Its major value is in its flavor. Onion ranks medium in calorific value, low in protein and very low in vitamins.

The quantity of onion produced is not enough to meet the present domestic requirement. The production of onion in the country accounts for less than 50% of total supplies in the major market centers of Nepal even during the harvesting season from April to June (Koirala *e.t al,* 1995). However, there is a continual demand of onion bulb throughout the year. There is lesser risk of over production of onion than that of other

vegetables because it can be sold at once after harvesting (Pandey and Singh, 1993). A large amount of dry onion is imported from India and even from China. Basically, onion is a long-day plant and planted in October –November and harvested in April - June. But the production in rainy season is constrained due to climatic factors. The bulb development was significantly retarded when maximum day temperature reached 40-45^{0}C (Shinde and Sontakke, 1993). At the harvesting time, farmers are compelled to sell their products at minimum price whereas there is scarcity of onion bulbs and skyline increase of its price from September to January. The harvesting period of late maturing onion coincides in the pre monsoon season and deteriorates the bulb quality after harvest and cause great economic losses so suggested for development of early type of short day onion which can mitigate the problem significantly (Bhattarai *et. al*, 1996). Long time storage of onion causes a great problem due to high humidity and high temperature. Large portions of bulbs are lost due to sprouting, rotting, rooting and shrinkage. Total storage losses of onion in about four month's period (June to September) were found about 37.9 % (Bhattarai and Subedi, 1996 and 1998).

The unavailability of quality seed in time, lack of low land and good irrigation facility are some other problems and are beyond the capacity of poor hill farmers for increasing the area, production and productivity of onion. For seed production, it takes two years and requires high cost and care for storage of bulbs for next year planting. The development of off-season production and annual seed production technologies may cope the above mentioned problems. It does not require low land and assured irrigation facility, and can be grown easily in upland condition. This study was conducted to verify, disseminate and upscale the off-season onion and annual seed production technology in the mid western hills of Nepal. The developed technologies are expected to utilize the much more working hours of women and poor farmers and help to improve living standard of rural poor farmers to some extent.

MATERIALS AND METHODS

Series of activities were conducted at Malika, Naule Katuwal, Chupra, Jarkot and Bijaura of Dailekh district in Mid Western Region of Nepal from 2008/09 to 2010/11. Base line surveys were conducted in each VDCs to know the status and existing situation of off-season onion production and annual seed production method. For base line survey, house hold questionnaires, transit walk and PRA check list and other PRA tools were applied. One day farmers' training was organized at Jarkot, Malika, Naule Katuwal and Kalbhairab. Detail methodologies for production of off-season onion through raising seedlings and annual seed production through use of off-season bulbs were given at that training. Different onion varieties (Agrifound Dark Red N-53 and Bemausami-1) were tested in the farmers' field as well as in the station for off-season production. Among the varieties tested, the promising variety Agrifound Dark Red was subjected to further dissemination to the farmers' field. For the verification and dissemination of off season onion production technology, 8-10 farmers in each site were selected. They were provided with technical and other inputs. Seeds were sown in the nursery on third week of June and transplanted on first week of August. Nursery bed was prepared as general practice in raised bed with the provision of plastic roof above 2 feet. For fresh bulb production, farmyard manure (compost) was applied @ 20t/ha and chemical fertilizers @ 100:50:100 kg N_2:P_2O5:K_2O/ha. Full dose of compost, phosphorus, potash and 1/2 dose of nitrogen were applied as basal dose before one day of transplanting (field preparation). Remaining 1/2 of nitrogen was splitted into 2 parts and applied as top dress at 30 and 60 days after transplanting. Similar dose of manure and fertilizers were applied for the seed production also. The seed samples were collected from different sites of the program area and were sent to Regional Seed Laboratory, Nepalgunj for its quality assessment. Observations on plant height, bulb length, bulb diameter, bulb weight, bulb rings, days to bulb harvest, bulb yield, green tops yield, income from bulbs, income from green tops, combined income from bulbs and green tops, production cost, net income, cost benefit ratio, days to seed harvest and seed yield for different sites were gathered and they were subjected to analysis of variance. Data was analyzed by using the statistical software package Genstat 532-2.

RESULTS AND DISCUSSION

Farmers training on off-season onion production

One day farmers' training was organized at Jarkot, Malika, Naule Katuwal and Kalbhairab. Detail methodologies for production of off-season onion through raising seedlings and annual seed production through use of off-season bulbs were given at that training. A total of 86 farmers (50 male and 36 female)

participated in these trainings. Due to rice planting season, participation of female farmers was not satisfactory as our expectation.

Baseline survey and impact study survey on off-season onion and seed production

Base line surveys were conducted in each place to know the status and existing situation of off-season onion production and annual seed production method. Altogether 100 farmers were interacted on off-season onion production technology. Very few farmers (5%) responded that they had heard little about off-season and seed production, but did not have technical knowledge and ideas. Remaining 95 % farmers were quite unaware about the technology. For base line survey, house hold questionnaires, transit walk and PRA check list and other Participatory Rural Appraisal (PRA) tools were applied.

Verification of the promising lines for off-season bulb production through seedlings at farmers' field in different locations

Two promising lines of onion N-53 and Agrifound Dark Red verified by Regional Agriculture Research Station, Lumle and District Agriculture Development Office, Bhairahawa and one another line bemaisami-1 (described by Budhathoki, Kedar and Parajuli, BN, 2065) were planted in 10 farmers field at Jarkot, 10 farmers field at Malika, 11 farmers field at Naule Katuwal and 4 farmers field at Ranchigaun. The number of farmers involved in Ranchigaun was fewer due to seedling damage at nursery stage due to heavy and continuous rains, hurricane and hailstones. The site Ranchigaon was later dropped due to poor co-operation from farmers and selected Bijaura as a new site. Among three lines of onion, N-53 and Bemausami-1 were completely unsuccessful, while the variety Agrifound Dark Red was successful in all locations. N-53 and Bemausami-1 seedlings could not perform better in the nursery stage (only 15-20% seedlings could survive and even seedlings transplanted could not form marketable fresh bulbs). The promising line of Agrifound Dark Red (more than 85% seedlings could survive in nursery stage leading to attractive marketable bulbs after transplanting in the main field) was subjected to further dissemination in various five sites of Dailekh district.

Demonstration of off-season onion production technology

Better performing variety Agrifound Dark Red seeds were sown for the production of bulbs in large area according to the availability of land in the farmers' field for the demonstration in each location. In each site there were 8-10 farmers involved. A total of 43 farmers were involved for the demonstration of selected genotype (Agrifound Dark Red) in their field. The demonstration became helpful for the further dissemination of technology in large scale. During the course of verification and dissemination of off-season onion bulb and annual seed production technology, different plant, bulb, seed and economic parameters were taken and they have been described below.

Plant height: Plant height is an important growth parameter and was measured from base to tip of the plant with the help of meter scale at maturity. Pooled analysis of the onion variety, Agrifound Dark Red showed a non significant difference in height for different sites (Table 1). However the longest plant height (53.47 cm) was recorded at Chupra and the shortest in Malika (50.27 cm) with mean plant height of 52.09 cm.

Bulb length: Generally short bulb is preferred for quality onion. Bulb length was recorded at harvesting stage. Pooled analysis of bulb length showed highly significant ($p<0.001$) effect of sites. In Jarkot, the shortest (3.93 cm) bulbs were recorded while the longest (4.76 cm) was noticed at Chupra with mean performance of 4.42 cm (Table 1).

Bulb Diameter: The diameter of the bulb was measured just after harvesting and average data have been presented in Table 1. Pooled analysis of bulb diameter showed highly significant difference among the sites. The bulb diameter ranged from 4.12 cm (Bijaura) to 4.87 cm (Malika) with mean diameter 4.56 cm (Table 1).

Bulb weight: Data concerning the weight of bulb is presented in table 1. The average weight of bulb was significantly affected by the sites ($p<0.001$). Pooled analysis of bulb weight showed the average bulb weight varied from 48.93 g (Bijaura) to 60.60 g (Malika) with mean weight of 55.49 g. Significantly heaviest bulbs were produced at Malika in both years i.e. 2009 and 2010.

Table 1: Performance of Agrifound Dark Red onion in different sites for different parameters (mean of 2008.2009 & 2010)

Sites	Plant height (cm)				Bulb length (cm)				Bulb diameter (cm)				Bulb weight (g)			
	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled
Chupra	52.0	58.0	50.4	53.5	4.8	5.0	4.5	4.8	4.9	4.8	4.8	4.8	62	58	58	59.
Jarkot	54.0	52.4	50.8	52.4	3.5	4.0	4.3	3.9	4.3	4.2	4.3	4.3	47	48	53	49
Malika	51.0	50.0	49.8	50.3	4.4	4.9	4.5	4.6	4.9	5.0	4.7	4.9	60	60	61	61
Naule	50.6	51.0	52.6	51.4	4.2	4.0	4.8	4.7	4.7	4.7	4.8	4.7	61	55	60	59
Mean	52.4	52.9	51.0	52.0	4.2	4.6	4.5	4.4	4.6	4.6	4.6	4.6	56	54	56	55
F-Value								<0.001				<0.001				<0.00
				0.24												1
LSD				Ns				0.31				0.19				2.3
CV%				8				9.5				5.7				5.7

Bulb rings: Data concerning the bulb rings showed non significant relationship among the sites. The pooled analysis of bulb rings showed that it varied from 7.80 (Malika) to Jarkot and Naule (7.93 at both sites) with mean bulb rings of 7.88 (Table 2).

Days to fresh bulb harvest: It is an important character indicating the earliness of the maturity. It was taken in days after transplanting. Pooled analysis on days to bulb harvest showed highly significant differences among the sites ($p<0.001$). Bulbs were harvested earliest at Malika (114.60 days after transplanting) followed by Chupra (117.20 days), while the latest bulb harvesting was possible at Jarkot (121.67 days after transplanting) with mean days to fresh bulb harvest 119.29 days (Table 2)

Marketable Fresh bulb yield : The yield of fresh onion bulb was significantly affected by sites ($p<0.001$). Pooled analysis showed that the highest fresh bulb (705.30 kg/ropani) was observed at Malika followed by Chupra (633.90 kg/ropani). Malika and Chupra have favorable soil and geographic location for off-season onion production. In those places it has been recorded fresh bulb production up to 1300 kg/ropani. The least fresh bulb was produced at Bijaura, Naule Katuwal and Jarkot with respective fresh bulb production of 305.70, 326.30 and 358.90 kg / ropani. These sites are some what shady with less preferred geographic location for off-season onion production. Besides these, farmers of those sites also paid less sincere attention towards the production of rainy season onion production. However, the quantity of fresh bulb production was observed to be in increasing trend from the year 2008 to 2010 (Table 2).

Research conducted in Nepal indicates that the varieties of onion cultivated in the country have potential yields ranging from 12 to 21 tons per hectare (MOAC, 2008). In the evaluation of different onion varieties (LR-241, N-53, Nashik Red and Red Creole) for off-season production, Gautam *et al.* (2006) obtained the highest fresh bulb yield (16.63 t ha^{-1} in the variety N-53 along with August transplanting date (15.31 t ha^{-1}). In the performance evaluation of common onion varieties (Arka Niketan, Punjab Red Round, Nashik Red, N-2-4-1, Agrifound Dark Red, Agrifound Light Red, Arka Kalyan, Pusa Red, Pusa Ratnar, Arka Madhavi and Arka Pitamber), Arka Niketan recorded the highest yield (21.06 t ha^{-1}) which was at par with Arka Niketan (19.64 t ha^{-1}) and Pusa Madhavi (18.96 t ha^{-1}), while Agrifound Dark Red and N-53 displayed moderately high yield of 18.06 and 17.85 t ha^{-1} respectively (Mohanty and Prusti, 2001, 2002). Rokaya *et al.* (2004) reported the highest bulb yield in the variety Nasik Red-53 (11734 kg/ha) followed by Nashik Lal (10153 kg/ha), Surkhet Local (10085 kg/ha) and Red Creole (5640 kg/ha) in the farmers' field trial in Kalbhairab VDC of Dailekh district. Bhagchandani *et al.* (1972), Pandey (1989) and Singh *et al.* (1991) reported better performance of N-53 and Agrifound Dark Red than other varieties, while Bhonde *et al.* (1992) did not find significant difference in the performance among 12 varieties tested in *Kharif* season. Out of these varieties, Arka Kalyan, Agrifound Dark Red, and N-53 were recommended for cultivation in rainy season, whereas Arka Niketan and Pusa Madhavi were recommended for winter season cultivation. This elucidated that *Rabi* varieties if grown in *Kharif* season could produce equally good bulb yield as that of *Kharif* varieties. Similar observation was also made by Bhonde *et al.* (1992)

Green tops yield: The green top yield of onion produced in off-season is also consumable and easily saleable in the local markets. So onion production in this season has great advantage to increase the income of poor hill farmers. The green tops yield also differed significantly ($p<0.001$) among the sites. Pooled analysis showed that the highest green tops yield was recorded at Chupra (503.2 kg/ropani) followed by Malika (446.3 kg) and the least yield of green tops was recorded at Bijaura (294.1 kg) with mean green tops yield of 390.9 kg/ropani (Table 2).

Table 2: Performance of Agrifound Dark Red onion at different sites for different parameters

Sites	Bulb rings				Days to bulb harvest (DAT)				Bulb yield (kg/ropani)				Green tops yield (kg/ropani			
	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled
Bijaura	8.2	7.6	7.8	7.9	122	120	121	121	312	292	313	306	286	287	309	294
Chupra	7.8	7.8	8.0	7.9	117.	117	117	117	610	649	643	634	497	529	483	503
Jarkot	8.2	7.6	8.0	7.9	121	121	121	122	285	382	410	359	284	374	271	309
Malika	7.6	7.8	8.0	7.8	115	114	114	115	691	698	726	705	446	444	448	446
Naule	7.8	7.8	8.2	7.9	122.	121	121	121	298	323	357	326	441	372	391	401
Mean	7.9	7.7	8.0	7.8	119	119	119	119	439	469	490	466	391	401	380	390
F- value				0.98				<0.00 1				<0.00 1				<0.00 1
LSD				Ns				1.15				14.7				22.7
CV%				8.5				1.3				4.3				7.9

DAT: Days after transplanting seedlings

Income from fresh bulbs: Pooled analysis on the income from the sale of fresh bulbs differed significantly among the sites ($p<0.001$). In the pooled analysis, the highest income per Ropani from the sale of fresh bulbs was obtained from Malika (Rs. 31808) and it was followed by Chupra (Rs. 28528). The least income per ropani of land from the sale of fresh bulb was taken in Bijaura (Rs. 13760) followed by Naule Katuwal (Rs. 14743), and Jarkot (Rs.16357). The mean income from a ropani of land from the sale of fresh bulb was recorded Rs. 21047. The cost of fresh bulb/kg was Rs. 40, 45 and 50 in the years 2008, 2009 and 2010 respectively. Budhathoki (2006) reported that, the onion bulb production through sets have less income (Rs 23660 / ropani) as compare to onion bulb production through seeds/seedlings (Rs. 30,000/ Ropani) (Table 3).

Income from green tops: Pooled analysis on the income from the sale of green tops differed significantly among the sites ($p<0.001$). In the pooled analysis, the highest income per ropani from the sale of green tops was obtained in Chupra (Rs. 12558) and it was followed by Malika (Rs. 11164). The least income per ropani of land from the sale of green tops was taken in Bijaura (Rs. 7393) followed by Jarkot (Rs. 7722), and Naule Katuwal (Rs.9953). The mean income from a ropani of land from the sale of green tops was recorded Rs. 9758. The cost of green tops/kg was Rs. 20, 25 and 30 in the years 2008, 2009 and 2010 respectively (Table 3).

***Income from fresh bulbs and green tops*:** Pooled analysis on the income from the sale of fresh bulbs and green tops differed significantly among the sites ($p<0.001$). In the pooled analysis, the highest income per ropani from the sale of fresh bulbs and green tops was obtained in Malika (Rs. 42971) followed by Chupra (Rs. 41086). The least income per ropani of land from the sale of fresh bulbs and green tops was taken in Bijaura (Rs. 21152) followed by Jarkot (Rs. 24061), and Naule Katuwal (Rs.24735). The mean income from a ropani of land from the sale of fresh bulbs and green tops was recorded Rs. 30801. The cost of fresh bulb/kg was Rs. 40, 45 and 50 and green tops Rs. 20, 25 and 30 in the years 2008, 2009 and 2010 respectively (Table 3).

Production cost : Data concerning the weight of bulb have been presented in table 3. The production cost significantly differed among the sites ($p<0.001$). Pooled analysis of production cost showed that production cost (Rs. /ropani) varied from Rs. 8860 (Jarkot) to Rs. 9421 (Chupra) with mean production cost of Rs. 9134 per ropani (Table 3).

Table 3: Production cost and income from off-season onion bulbs and green tops at different sites of Dailekh

Sites	Income from bulbs (000 Rs./ropani)				Income from green tops (000 Rs./ropani)				Combined income from bulbs and green tops (000 Rs./ropani)				Production cost/ropani (000 Rs.)			
	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled
Bijaura	12.5	13.1	15.6	13.7	5.7	7.1	9.2	7.3	18.2	20.3	24.9	21.1	8.5	9.0	9.5	9.0
Chupra	24.4	29.0	32.1	28.5	9.9	13.2	14.5	12.5	34.3	42.2	46.6	41.0	8.8	9.3	9.9	9.4
Jarkot	11.4	17.1	20.4	16.3	5.6	9.3	8.1	7.7	17.0	26.4	28.6	24.0	8.3	8.8	9.3	8.8
Malika	27.6	31.4	36.0	31.8	8.9	11.1	13.4	11.1	36.6	42.5	49.7	42.9	8.8	9.3	9.4	9.2
Naule	11.9	14.5	17.8	14.7	8.8	9.3	11.7	9.9	20.7	23.8	29.6	24.7	8.8	9.2	9.3	9.1
Mean	17.5	21.0	24.4	21.0	7.8	10.0	11.4	9.7	25.3	31.0	35.9	30.8	8.6	9.1	9.5	9.1
F-value				<0.001				<0.001				<0.001				<0.01
LSD				698				594				87				155
CV%				4.5				8.3				3.9				2.3

Net income: It was obtained subtracting production cost (Rs. /ropani) from the combined income from fresh bulbs and green tops (Rs. /ropani). Net income differed significantly ($p<0.001$) among the sites. Pooled analysis on net income showed that the highest income was noted in Malika (Rs. 33771/ropani) followed by Chupra (Rs. 31665). Similarly, the lowest net income was found in Bijaura (Rs. 12132) and it was followed in Jarkot (Rs. 15201) and Naule Katuwal (Rs. 15569). In the year 2010 the highest net income was recorded at Malika with net income Rs. 40326 per ropani (Table 4).

Cost benefit ratio: The cost benefit ratio was significantly affected by sites ($p<0.001$). Pooled analysis showed that the highest cost benefit ratio (1:4.66) was observed at Malika followed by Chupra (1:4.35). Pooled analysis of cost benefit ratio showed that least cost benefit ratio was noted in Bijaura (1:2.34) followed by Jarkot and Naule Katuwal (1:2.69 at both sites). The mean cost benefit ratio of 1:3.35 was noted (Table 4). The cost benefit ratio has been found to increase in different years. In the year 2010, it has been observed up to 1:5.28 at Malika (Table 4).

Table 4: Cost benefit analysis of fresh bulb and green tops production from Agrifound Dark Red onion during off-season at different sites

Site	Net Income (Rs./ropani)				Cost benefit ratio			
	2008	2009	2010	Pooled	2008	2009	2010	Pooled
Bijaura	9700	11301	15396	12132	1:2.14	1:2.25	1:2.62	2.34
Chupra	25456	32869	36670	31665	1:3.87	1:4.50	1:4.67	4.35
Jarkot	8716	17627	19260	15201	1:2.05	1:2.99	1:3.06	2.69
Malika	27736	33252	40326	33771	1:4.12	1:4.58	1:5.28	4.66
Naule	11900	14564	20202	15569	1:2.34	1:2.57	1:3.16	2.69
Mean	16702	21923	26379	21668	1:2.91	1:3.38	1:3.76	3.35
F-probability				<0.001				<0.001
LSD				860.6				0.1005
CV%				5.4				4.1

Seed Production

Days to seed harvest: The days to seed harvest differed significantly among the different sites ($p<0.001$). The mean days to seed harvest after transplanting of bulbs was found to be 176.88 days. Maximum days for seed maturity (after transplanting of bulbs) was taken at Jarkot (179.07 days) followed by Naule Katuwal (178.13 days). The minimum days for seed maturity was noted in Malika and Chupra (175.53 days at both sites) followed by Bijaura (176.13 days) (Table 5).

Seed yield: Pooled analysis of seed yield showed significant difference among the sites ((p<0.001). The mean seed yield for different sites recorded was 23.51 kg/ropani. The highest seed yield was measured at Malika (31.67 kg/ropani) and it was followed by Chupra (29.60 kg) and Bijaura (22.67 kg). Seed yield/ropani was obtained least at Jarkot (16.33 kg) followed by Naule Katuwal (17.47 kg) (Table 5).

Table 5: Seed production performance of Agrifound Dark Red onion at different sites of Dailekh

Site	Days to seed harvest (DAT)				Seed Yield (kg/ropani)			
	2009	2010	2011	Pooled	2009	2010	2011	Pooled
Bijaura	176.20	176.40	175.80	176.13	22.60	22.00	22.80	22.47
Chupra	176.00	175.80	174.80	175.53	28.60	29.60	30.60	29.60
Jarkot	179.40	179.20	178.60	179.07	15.40	16.40	17.20	16.33
Malika	175.80	175.40	175.40	175.53	29.60	31.00	34.40	31.67
Naule	178.00	178.00	178.40	178.13	16.80	18.20	17.40	17.47
Mean	177.08	176.96	176.60	176.88	22.60	23.44	24.48	23.51
F-probability				<0.001				<0.001
LSD				1.572				1.286
CV%				1.2				7.5

DAT: Days after bulb transplanting

Seed quality assessment: In the year 2008/09 seed samples from Jarkot, Naule Katuwal, Chupra and Malika along with the samples from India (old stock and new stock) were sent to Regional seed lab, Nepalgunj for the analysis of different parameters for the evaluation of seed quality produced by annual method. The details of seed sample analysis results have been presented below (Table 6). Among the above mentioned 6 samples, seed samples from Naule Katuwal, Chupra and Malika were found to be far better than those of Indian samples except the seed sample from Jarkot (Table 6). Similarly, in the year 2009/10 six onion seed samples from different project areas (5 new samples) and one from old lot were sent to Regional seed lab, Nepalgunj for the analysis of different parameters. The details of seed sample analysis results have been presented below (Table 7). All the seed samples analyzed were Agrifound Dark Red. Among the samples tested, seeds from Malika, Chupra, Naule Katuwal and Bijaura were found to be the good seeds, while, seeds from Jarkot and old lot one were found not to meet the quality of good seed.

Table 6: Analysis of seed samples to evaluate the quality of seeds produced by annual method (2008/09)

Source	Purity (%)	Other seed (%)	Weed seeds (%)	Inert matter (%)	Germination (%)	Viable seed (%)	Remark
Jarkot	98.7	0	0	1.3	60	59.2	Poor
India (New stock)	98.7	0	0	1.3	65	64.1	Moderate
Naule Katuwal	98.6	0	0	1.4	88	86.7	Good
India (Old stock)	99.1	0	0	0.9	50	49.5	Poor
Chupra	99.3	0	0	0.7	92	91.3	V. Good
Malika	99.3	0	0	0.7	86	85.3	Good

Table 7: Analysis of seed samples to evaluate the quality of seeds produced by annual method (2009/10)

Source	Purity (%)	Other seed (%0	Weed seed (%)	Inert matter (%0	Moisture (%)	Germination (%)	Viable seed (%)	Remark
Jarkot	99.8	0	0	0.2	8.8	45	44.9	Poor
Malika	99.8	0	0	0.2	9.0	89	88.8	Good
Naule Katuwal	99.7	0	0	0.3	9.0	86	85.8	Good
Old stock	99.9	0	0	0.1	8.9	13	12.9	Poor
Chupra	99.4	0	0	0.6	8.9	85	84.4	Good
Bijaura	99.8	0	0	0.2	8.9	84	83.8	Good

CONCLUSION

The performance obtained during the course of verification, dissemination and up-scaling of the program off-season onion production technology, Agrifound Dark Red variety was found superior to others in terms of yield attributing parameters in the context of Dailekh (mid western region). If farmers can increase the area for its cultivation in commercial scale cost benefit ratio can be increased more than presented with lucrative returns. Thus, it can be recommended for commercial production. However, its further verification and up-scaling in other similar sites of eastern, western, central, mid western, far western regions of Nepal is equally important for its wider dissemination.

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REFERENCES

Bhattarai S.P., B. Adhikari and P.P., Subedi (1996). Effect of variety, planting date, and seedling age and weed control on survival, bolting and yield in normal season onion 1993/94. *LARC Working Paper No. 96/6*. Kaski, Nepal; Lumle Agriculture Research Centre.

Bhattarai S.P.and Subedi, P.P. (1998). Effect of curing and storage method on post-harvest loss of bulb onion in low hills. *LARC, Working Paper No. 98/20*. Lumle Agriculture Research Centre, Pokhara, Nepal.

Budhathoki, Kedar (1997). The effect of environmental conditions on the growth and development of onion (*Allium cepa* L) in Nepal. A thesis presented in partial fulfillment for the degree of Doctor of Philosophy (Ph D) at the Wye College, University of London.

Budhathoki, K. (2006). *Bajar Mukhi Arganic ra Be mausami tarkari Kheti Pravidhi* (Nepali Version). Published by Mrs. Basanti Budhathoki, Nakhu, Lalitpur, Nepal.

Bhonde, S.R., Srivastava, K.J. and Pandey, U.B. (1992).Evaluation of varieties for growing "Rangda" crop of onion (*Allium cepa* L.) in Nashik area of Maharastra. *Maharastra J. Hort.* 6 (2): 39-42

Gautam, I.P., Khatri, B. and Paudel, G.P. (2006). Evaluation of different varieties of onion and their transplanting times for off-season production in mid hills of Nepal. *Nepal Agric. J.*

Koirala, G.P., Thapa, G.B and Joshi, G.R (1995). Can Nepalese farmers compete in the domestic market? A comparison of the relative setting and performance in agriculture of Nepal and India? Research Report Series No.34. Win rock International. PO Box 1313, Kathmandu, Nepal.

MOAC (2008). Final Report Product Chain Study Onion

Mohanty, B.K. and Prusti, A.M. (2001). Performance of common onion varieties in Kharif seasons. Journal of Tropical Agriculture. 39: 21-23

Mohanty, B.K. and Prusti, A.M. (2002). Varietal performance of onion in rainy season. *Indian J Agric. Res.*, 36 (3): 222 – 224

Nashik News (2010).

Pandey, U.B. (1989). Onion (*Allium cepa* L.). *Indian Hort.* 33(4) and 34(1): 58-62

Rokaya, B.B; Bhandari K.B and K.C. R.B. (2004). Study on off-season onion production in river basin environment of mid and far-western regions of Nepal. *Proceedings of the Fourth National Workshop on Horticulture* Held on March 2-4, 2004, Kathmandu, Nepal.