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Assessment of Onion Seed Quality Intercropped with Beet Leaf

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Abstract: To investigate the efficient strategy for onion seed production in intercropping systems a field experiment was conducted at CCS HAU, Hisar in two *rabi* seasons (2018-19 & 2019-20). Onion was grown as the main seed crop while beet leaf an intercrop with different leaf cutting frequencies. The superior onion seed quality parameters were in sole onion treatment *i.e.,* test weight (3.73g), germination (79.7%), vigour I (1285.2), vigour II (137.5), tetrazolium (94.0%), electric conductivity (0.20 µS/cm/50 seeds) and accelerated ageing test (48.3%). Among intercropping treatments, the highest seed quality parameters were from combination, onion + beet leaf (1 row) with 3 cuttings *i.e.,* test weight (3.53g), germination(75.0%), vigour I (1187.1), vigour II (122.7), tetrazolium (92.0%), electric conductivity (0.21 µS/cm/50 seeds) and accelerated ageing test (46.3%). The minimum seed quality parameters were from combination, onion + beet leaf (2 rows) 3 cuttings and left for seed crop.

Keywords: *Allium cepa* L. *Beta vulgaris*, Cutting frequency, Intercrop, Row pattern, Seed quality

Onion (*Allium cepa* L.), a member of the Alliaceae family is one of the most significant vegetable crops produced globally. The average productivity in India is 18.1 t/ha, and leads the world in terms of area (1.43 million hectare) and bulb production (26.74 million metric tonne) (Anonymous 2020). The ability of farmers to obtain better onion seed has previously been hampered by a lack of quality seed supply through the official system and lack of technical assistance for the promotion of informal seed systems on the other. Onion crop is being grown over a greater area, which is increasing the need for high-quality seeds (Chengappa et al 2012). Achieving productivity targets depends on having healthy, viable, highest standard seed available during planting that enhances crop productivity and yield by 10-15% (Gaur et al 2020). As it continues to lose viability after 1-1.5 years of storage in an ambient environment, onion seed is regarded as an orthodox and poor store in this regard (Pritchard and Nadarajan 2008). Promotion of seed production by the farmer to fulfil his seed requirement but low-quality seeds are the main constraint with onion crops because they cause sluggish and asynchronous germination as well as a significant proportion of aberrant seedlings (Borowski and Michaek 2006), so that seed production requires skills otherwise onion seed sold by private companies at very high rates. Since germination tests rely on pure seed components, purity analyses and germination tests complement one another (Haque et al 2007). Therefore, the purity analysis and germination tests must be considered to assess the real planting value of the seed. Beet leaf (*Beta vulgaris* var. bengalensis) is one of the most common green vegetables cultivated and consumed in India. It may be produced all year long and is well-liked for its high nutritional content, although the primary crop is typically taken from October to November. After seeding, its leaves are available for the first cutting around 35 days later and further cuttings are taken at intervals of 15-20 days (Kumar et al 2022). Intercropping has been used extensively because of its numerous advantages, which include optimum land utilization (Mohammed et al 2022), weed suppression (Rad et al 2020), advantageous ecosystem services, promoted pest management (Himmelstein et al 2017), and fertility of the soil enhanced performance via the fixation of nitrogen by the bacteria *Rhizobium* (Li et al 2014). Intercropping also has been regarded as a method to increase agricultural sustainability (Maitra 2020). The selection of an optimum intercrop mixture, population density, and intercrop planting geometry (Yang et al 2015) can all improve crop productivity and farmers income. The experiment was conducted to examine the impact of cutting frequency and row patterns of beet leaf on onion crop seed quality in intercropping and to optimize their crop production.

MATERIAL AND METHODS

Experimental details: The field experiment was conducted at CCS Haryana Agricultural University, Hisar, which is situated at 29° 10' latitude north, 75° 46' longitude east, and 215.2 m above mean sea level in the subtropical climate zone of India. Field experiment was conducted during the *rabi* season 2018-19 and 2019-20 in a randomized block design and replicated three times. The onion variety selected was Hisar onion 3 (HO-3) and the beet leaf variety HS 23. Recommended package of practices followed for optimum growth of both the crops (Anonymous 2021). Seed was harvested when 50% of black seeds were exposed on an umbel, dried and threshed manually. Different seed quality parameters like test weight, standard germination (SG) test (%), tetrazolium (Tz) test (%), seed vigour index-I & II, accelerated ageing (AAT) test (%) and electric conductivity (EC) test (µS/cm) were performed. The data were statistically analyzed using the OPSTAT software.

Test weight (g): This was based on one thousand (1000) randomly selected seeds from the seed lot of each treatment per replication.

Standard germination test (%): For the standard germination test, 50 randomly selected seeds from every treatment per replication were placed in germination papers inside the germination chambers set at 25± 1°C and on the 14^{th} day germination was counted.

Tetrazolium (Tz) test: To performing the tetrazolium staining test seeds were sliced longitudinally through the midsection of the distal half, then placed in petri dishes with 2.5 ml of 1% solution by mass of 2,3,5 triphenyl tetrazolium chloride. After a 24-h staining time in the germination chamber, seeds that displayed a completely stained embryo and white endosperm were classified as viable (ISTA 1999). The percentage of viable seeds after tetrazolium staining was calculated as the total number of viable seeds.

Vigour indices: At the time of counting the standard germination, 20 normal seedlings per replication were randomly selected. The length of the shoot was measured from the tip to the end of the shoot and the length of the radical was measured from the tip of the root to the end of the root, in centimetres and the average length was calculated. Its fresh weight (FW) and dry weight (DW) of 20 seedlings was observed. Seedlings were dried in a hot air oven for 24 h at 80 ± 1°C. The dried seedlings of each replication were weighed for dry weight of seedling of each treatment. Seedling vigour indices were calculated according to the method suggested by Abdul-Baki and Anderson (1973).

Seed vigour index I = seed germination (%) × average seedling length (cm)

Seed vigour index II = seed germination (%) × average dry seedling weight (mg)

Electrical conductivity (EC) (µS/cm): Fifty seeds selected randomly from each seed lot were soaked in beakers each containing 75 ml of distilled water. The seeds were immersed completely in water and the beakers were covered with foil. Thereafter, these samples were kept in the germinator at 25 + 1°C for 24 hours (h). The electrical conductivity of seed leachates was measured by 60 direct reading conductivity meters. The conductivity was expressed in µS/cm/seed.

Accelerated ageing (AAT) Test (%): For testing the accelerated ageing under artificial conditions, 2 grams of freshly harvested seeds for each of three replications were taken and were put on the stainless-steel mesh into a plastic box with distilled water in the bottom and placed in an accelerated ageing chamber at 40 ± 1°C and about 100% RH for 48 hours. After the incubation, 50 randomly selected seeds were tested for germination, as per the ISTA. Accelerated ageing percentage was calculated by just counting the normal seedlings after germination in the germinator as per the standard germination percentage.

RESULTS AND DISCUSSION

Onion seed yield (q/ha): The onion seed yield was influenced by the beet leaf intercropping systems when compared with the onion sole crop. This variation might be due to higher plant population in intercropping treatments and more competition for resources *i.e.,* land, water, space and nutrients as compared to the sole onion crop (Table 1). The maximum seed yield (5.81q ha^{-1}) was in T1. The Intercropping treatment (T2) resulted in seed yield reduction when compared to onion sole crop (T2: 4.87 q ha^{-1} and T1: 5.81 q ha^{-1}). The seed yield was further reduced when the number of beet leaf rows was increased (1 to 2 rows) *i.e.,* T9 (4.80q ha^{-1}) as compared to T1 and T2. The minimum seed yield was from T10 (3.29q ha^{-1}). The significant seed yield reduction was T9, because the beet leaf was also left for seed with onion seed crop in an earlier stage, under these conditions beet leaf crop grew taller than the onion crop and influenced the onion seed yield by shedding effects. The number of rows and cuttings frequency of beet leaf also influenced the onion seed yield and may due to the negative shading effects of beet leaf on onion crop plants due to more height of beet leaf crop as the treatment was left for seed after 3^{rd} or 4^{th} cuttings. The beet leaf did not show shading effects on the onion umbels rather than crop competitions when was left for seed crop after 5^{th} leaf cutting. The yield reductions might be also due to spatial competition, nutritional competition, waster stress and few numbers of honey bee visits for doing pollination in high-density plant populations under intercropping conditions. Liu et al (2016) also reported that population density and intercropping of sorghum and soybean may alter their growth and yield patterns through responses to light and physiological attributes as compared to their performance in standard densities and sole crop conditions. Obadoni et al (2005) observed from the intercropping mixtures that the yield of tomato was consistently greater in plots containing higher and equal proportions of tomato with cowpea, while cowpea yield was highest in its sole treatments and also performed well when combined with 67% cowpea and 33% tomato. Singh and Kushwaha (2012) reported that intercropping radish or spinach with potatoes decreased potato output by 17% and 8%, respectively. This could be a result of intercrop competition for the potato, which would reduce per-plant production and affect total tuber yield.

Test weight (g): The superior test weight (3.73g) was recorded from the T1 (sole onion seed crop). In the intercropping treatments the highest test weight (3.53g) was in T2 followed by treatment T9 (3.48g). The minimum test weight (2.59g) was in T10. The cutting frequency and the number of beet leaf rows influenced the onion test weight in the intercropping patterns. There was no significant reduction in onion test weight at minimum frequency leaf cuttings (3 cutting) and uprooting of the beet leaf crop compared to minimum leaf cutting and left for seed crop. This might be due to the reduced crop's competition by uprooting the beet leaf after 3rd cutting, and from now the crop grew as a sole crop. So, these treatments (T2 and T9) performed the test weight as like sole onion seed crop. The test weight of the onion was further reduced in the subsequent cuttings from the 3rd to 6th beet leaf cutting. These results indicate that minimum leaf cutting leads to more test weight and furthermore cutting leads to reduced test weight, which might be due to the different crop competitions. The test weight of onion was significantly reduced when beet leaf crop was also left for seed with onion seed crop in intercropping. It was significantly reduced in T3 and T10 of 3 leaf cutting and left for seed crop followed by treatments of 4th and 5th leaf cuttings. Two-row treatments always influenced test weight as compared to the one-row treatment on the same frequency of leaf cuttings. Huang et al (2019) also reported that intercropping system and their yield are closely related to planting density and 100 grain weight.

Standard germination (%): Among intercropping treatments, the maximum standard germination percentage was in T2 (75%). The test standard germination results amongst the intercropping treatments might be due to single row and earliest uprooting (after 3rd cutting) of the beet leaf crop responsible for reducing the competition for nutrients, light, space and better photosynthetic accumulations under the field conditions and enhanced the seed storage ingredients. The treatment was at par with two-row treatment T9 (74%) on the same frequency of beet leaf cutting (Table 1). Minimum standard germination was recorded from the treatment T10 (58.3%). This minimum standard germination percentage might be due to higher crops' competition for nutrients, sunlight and space, and most are the shading effects of beet leaf on onion umbels. Improper seed development resulted in a low accumulation of food reserves, which ultimately led to inferior germination under laboratory

Table 1. Effect of cutting frequency and beet leaf rows on seed yield, test weight, standard germination test and vigour index-I of onion seed produced in intercropping (Pooled)

Treatments↓ / Quality parameters of onion seed →	Seed yield (q/ha)	Test weight (g)	Std. germination (%)	Vigour index I
T_1: Onion seed crop (sole crop)	5.81	3.73^{a}	79.7	1,285.20
T_2: Onion + Beet leaf (1 row) with 3 cuttings	4.87^{a}	3.53^{ab}	75.0^{a}	1187.1^{a}
T_3: Onion + Beet leaf (1 row) 3 cuttings and left for seed crop	3.41^{e}	2.74^{k-m}	60.0^{lm}	818.6^{lm}
T_4: Onion + Beet leaf (1 row) with 4 cuttings	4.74^{b}	3.42^{b-d}	72.0^{bc}	1122.8^{a-c}
T_5: Onion + Beet leaf (1 row) 4 cuttings and left for seed crop	3.61^{d}	2.82^{i-l}	64.3^{i-k}	931.5^{i-k}
T_6: Onion + Beet leaf (1 row) with 5 cuttings	4.36^{c}	3.32^{b-f}	70.7^{c-e}	1078.4^{c-e}
T_7: Onion + Beet leaf (1 row) 5 cuttings and left for seed crop	3.88	2.98^{h-j}	66.0^{f-i}	971.0^{f-i}
T_8: Onion + Beet leaf (1 row) with 6 cuttings	4.16	3.12^{f-h}	68.0^{fg}	1028.8^{d-g}
T_9: Onion + Beet leaf (2 rows) with 3 cuttings	4.80^{ab}	3.48^{bc}	74.0^{ab}	1160.5^{ab}
T_{10}: Onion + Beet leaf (2 rows) 3 cuttings and left for seed crop	3.29	2.59^{m}	58.3^{m}	776.8^{m}
T_{11}: Onion + Beet leaf (2 rows) with 4 cuttings	4.49	3.36^{b-e}	71.0^{cd}	1097.4^{b-d}
T_{12}: Onion + Beet leaf (2 rows) 4 cuttings and left for seed crop	3.46^{e}	2.76^{k-m}	62.3^{kl}	889.0^{j-l}
T_{13}: Onion + Beet leaf (2 rows) with 5 cuttings	4.29^{c}	3.25^{d-g}	68.3^{ef}	1039.6^{d-f}
T_{14}: Onion + Beet leaf (2 rows) 5 cuttings and left for seed crop	3.66^{d}	2.90^{i-k}	65.3^{h-j}	953.6^{h-j}
T_{15}: Onion + Beet leaf (2 rows) with 6 cuttings	4.04	2.99^{hi}	67.3^{f-h}	1008.9^{e-h}
CD (p=0:05)	0.08	0.21	2.6	70.5

q - Quintal, ha - Hectare, wt. - Weight, g - Gram, Std. - Standard conditions. Whereas superior standard germination was observed in sole onion crop T1 (79.7%) compared to the intercropping treatments, the best results might be due to crop autonomy. The data revealed that the onion seed produced in one-row patterns and low-frequency cutting (3 or 4 cutting and uprooting) beet leaf resulted in significantly higher standard germination percentages (tested in the laboratory) as compared to seed produced on the same frequency cuttings (3 or 4 cutting) and left for seed (same trend as test weight). In these treatments, the standard germination of onion seed was significantly reduced. The higher plant population, or intercropping, reduces seed vigorousness and seed germination. Gowda et al (2020) also reported that significantly high seed germination, seedling length and dry weight, vigor index I and II and lower EC in sole chickpea compared to the intercropping treatments.

Vigour index I: The maximum vigour index I was recorded from intercropping treatment T2 (1187.1) followed by T9 (1160.5). The T10 recorded minimum seed vigour I (776.8), A higher vigour index reflects healthy or best-quality seeds, and a lower vigour index reflects inferior-quality or unhealthy seeds. More crop competition under field conditions reduces the seed quality, as the beet leaf crop left for seed after the 3rd cutting, which grew taller than the onion crop, was responsible for the shading effect on onion seed umbels. Furthermore, two rows of beet leaf between the onion lines increase the plant population density, exerting different types of crop competition and ultimately reducing the seed vigour index I. The superior vigour index-I of sole onion treatment T1 (1285.2) might be due to low population density and the absence of crop competition. Similar results were also reported by Gowda et al (2020). Vigour index follows the same trend (Table 1).

Vigour index II: The maximum seed vigour II was in T2 (122.7) and T10 resulted in the minimum (65.7) vigour II among the intercropping treatments. Treatment T1 (sole onion) resulted in the highest vigour index II (137.5) among the other intercropping treatments (Table 2). The best seed vigour index results in sole onion might be due to more seed reserve accumulation under less plant population density in the absence of any type of competition and highly vigorous seeds. But under the intercropping treatments, the planting density reduced the seed vigour and seed quality. After uprooting the beet leaf crop after a few cuttings (after 3rd cutting), the treatments performed as sole onion seed crops after only slight influences.

Tetrazolium (Tz) test: The results of the tetrazolium test revealed that the maximum test percent was in T2 (92%) and was regarded as the more vigorous and healthy seed. The minimum was recorded in T10 (71.3%), which shows more dead embryos, less vigorous seed, and inferior seed quality. The T1 recorded superior Tz test results (94%) concerning the other intercropping treatments and having highly vigorous and healthy seeds with higher germination

Table 2. Effect of cutting frequency and beet leaf rows on seed vigour index II, tetrazolium test, electric conductivity (ECe) and accelerated ageing test (AAT) of onion seed produced in intercropping (Pooled)

Treatments	Vigour index II	Tz Test (%)	ECe (µS/cm)	AAT (%)
T_1	137.5	94.0^{a}	0.20^{a}	48.3^{a}
T_2	122.7^{a}	92.0^{ab}	0.21^{ab}	46.3^{ab}
T_3	69.3^{kl}	74.0^{kl}	0.39^{lm}	31.7^{ij}
T_4	113.3^{a-c}	90.0^{a-d}	0.23^{a-d}	44.3^{b-d}
T_5	78.8^{i-k}	76.7^{i-k}	0.35^{i-k}	32.7^{ij}
T_6	105.1^{c-e}	88.7^{b-f}	0.25^{c-f}	40.3^{ef}
T_7	87.4^{f-i}	80.7^{i}	0.33^{hi}	34.3^{i}
T_8	95.2^{e-g}	86.0^{d-h}	0.28^{fg}	38.3^{f-h}
T_9	120.7^{ab}	91.3^{a-c}	0.22^{a-c}	45.3^{bc}
T_{10}	65.6^{l}	71.3^{l}	0.41^{m}	30.7^{j}
T_{11}	110.1^{b-d}	89.3^{b-e}	0.24^{b-e}	43.0^{c-e}
T_{12}	76.6^{i-l}	75.3^{jk}	0.36^{i-l}	33.3^{ij}
T_{13}	98.2^{ef}	86.7^{d-g}	0.25^{c-f}	38.3^{f-h}
T_{14}	85.0^{g-j}	78.7^{ij}	0.34^{ij}	33.0^{ij}
T_1	91.0^{f-h}	85.3^{e-h}	0.30^{gh}	37.3^{gh}
CD (p=0:05)	11.5	4.5	0.03	2.8

Tz -Tetrazolium, EC- Electric conductivity, AAT - Accelerated ageing test; See Table 1 for details possibility under field conditions due to more alive embryos in seeds (Marcos 2015).

Electric conductivity (ECe) test: The electric conductivity is negatively correlated with the quality and vigour of the seed. Lower seed EC readings represent positive or better test results whereas maximum readings show worse seed quality results. The minimum electric conductivity was in the sole onion seed crop treatment T1 (0.20 μS/cm/50 seeds) and was at par with T2 (0.21 μS/cm/50 seeds), which was an intercropping treatment. The seed quality was considered good and healthy under the seed standards. The maximum electric conductivity (0.41 μS/cm/50 seeds) was in T10, which was regarded as having the lowest seed vigour and unhealthy seed standards. The results indicated that the number of rows and cutting frequency of the beet leaf crop, along with the left for the seed crop, also influenced the electric conductivity of onion seed while influencing quality.

Accelerated ageing test (AAT): The maximum germination (46.3%) was in T2 after inducing under artificial environmental conditions in the intercropping treatments. This minimum ageing and maximum germination rate results in the seed being considered vigorous and of good quality. The minimum germination (30.7%) was in T10 after artificial ageing which was considered a poor seed with less storage ability, superior germination (48.3%) from the sole onion crop (T1) was recorded amongst all the treatments after the artificial ageing. The superior germination of the sole onion seed crop might be due to the most vigorous, healthy, and best quality seed produced in single crop conditions. This seed was regarded as having good storage ability for a longer duration. The figures for accelerated ageing with similar superscripts are significantly not different (Table 2). Intercropping influenced the seed ageing test results, but the intensity of the influence depends upon the number of rows, frequency of cutting, and taking of the seed crop of the beet leaf.

The seed quality parameters of onion that the treatments followed the different quality trends under different intercropping combinations but similar trending patterns were observed in all the seed quality parameters. The seed quality parameters were gradually influenced by the cutting frequency and row patterns or population intensity under intercropping systems. The uprooting of the beet leaf crop after few leaf cuttings resulted in improved seed quality of onion and also fulfilled the minimum required seed quality standards. Slightly but not significantly the row pattern (one-row and two-rows) also influenced the seed quality parameter at the same frequency of cutting but not more than the cuttings frequency. The seed quality parameters of onion were significantly reduced when the beet leaf crop produced seed in the same treatment as the onion seed. In the treatments in which the beet leaf was left for the seed after a few leaf cuttings (3^{rd} and 4^{th} cutting), the seed quality parameters were significantly reduced and could not fulfil the minimum quality standards of the seed, especially the standard germination. This inferior seed quality might be due to the higher plant population intensity, shade effect of beet leaf crop on onion umbels and more crop competition. Due to these circumstances, a low amount of photosynthates accumulates in the seed's reserve. This higher cropping intensity was also responsible for more fungal and bacterial disease infections that made the plant weak and sick. Wekesa et al (2015) reported that pure stands yielded significantly higher yields than intercrops and suitable quality attributes to be used as seed. Gangadhar et al (2018) reported that significantly higher oil yield and oil content of safflower were recorded with their pure stands of the crops. But when compared with the different intercropping systems, the highest oil yield of safflower was recorded in safflower + linseed (1:2) 30 cm rows (374 kg ha^{-1}), and the highest oil content was recorded in safflower + linseed (1:1) 30 cm rows (30%). Seed deterioration often begins as the seeds continue to dry out to the harvest maturity stage after reaching physiological maturity (Delouche 2021). The basic quality of seed was determined by the degree and severity of field degradation (*i.e.*, weathering); except for rare conditions, seed quality may be maintained during harvest and subsequent procedures but cannot be improved beyond the level at harvest. Oshone et al (2014) studied the physical, physiological, and health qualities of common bean seed produced by smallholder farmers using sole crop and intercropping systems. All samples of seed obtained from sole and intercropping cropping systems met the national seed standard for a common bean seed (95%) with pure seed proportion above 98%. The most prevalent bacterial and fungal ailments associated with the seed samples were common bacterial blight and *Aspergillus flavus*. The farmers could grow and use seed produced under sole and intercropping systems in places with limited agricultural land as long as the proper production and post-harvest management procedures were followed.

Correlation coefficients: The estimates of correlation coefficients among different characters have been presented in. The results of correlation studies showed that seed yield /plant, seed yield ha^{-1}, and test weight exhibited highly significant and positive with seed quality parameters (Table 3). The correlation coefficient was highly significant and positive correlation. The seed yield per plant revealed and exhibited highly significant and positively correlated with standard germination (0.961), seedling length (0.895),

Table 3. Estimation of correlation coefficients between seed yield with seed quality parameters of onion in intercropping

Seed quality parameters	YP^{-1}	Y ha^{-1}	Test wt.	Std. G	SL	SF wt.	SD wt.	V-I	V-II
Seed yield /plant (g)	1	-	-	-	-	-	-	-	-
Seed yield (q/ha)	0.973**	1	-	-	-	-	-	-	-
Test weight (g)	0.955**	0.973**	1	-	-	-	-	-	-
Std. germination (%)	0.961**	0.978**	0.982**	1	-	-	-	-	-
Seedling length (cm)	0.895**	0.926**	0.964**	0.973**	1	-	-	-	-
Seedlings' fresh wt. (mg)	0.912**	0.943**	0.970**	0.972**	0.971**	1	-	-	-
Seedlings' dry wt. (mg)	0.959**	0.968**	0.993**	0.984**	0.968**	0.972**	1	-	-
Vigour index-I	0.952**	0.972**	0.982**	0.998**	0.984**	0.975**	0.985**	1	-
Vigour index-II	0.975**	0.983**	0.991**	0.993**	0.963**	0.968**	0.996**	0.991**	1

YP^{-1}- Seed yield per plant, Y ha^{-1}- Yield per hectare, Test wt. - Test weight, Std. G- Standard germination- SL- Seedling length, SF wt.- Seedlings fresh weight, SD wt.- Seedlings dry weight, V-I- Vigour index-I, V-II- Vigour index- II, **Significant level at (p = 0.05)

seedling fresh weight (0.912), seedling dry weight (0.959), and seed vigour index-I (0.952) and seed vigour index-II (0.975). Such relationships suggested that high values for standard germination, seed vigour index-I, seed vigour index II, seedling fresh and dry weight could be assumed for intercropping systems that additionally had high seed yield per plant, seed yield per hectare and weight of the thousand seeds. Basaiwala et al (2013), and Panwar et al (2018) also found a highly positive correlation between seed vigour indices, seedling fresh weight, seedling dry weight, and standard germination with seed yield per plant seed yield ha^{-1} relationship in vegetable pea.

CONCLUSION

The yield and quality standards of onion seed depend upon row patterns and cutting frequency along with the seed production of beet leaf. The seed produced under sole crop conditions was best in yield and quality parameters and also fit the minimum seed quality standards. The decision to intercrop beet leaf with onion affects the farmer's yield and quality of seed and could affect his income as intercropping influences the seed yield. However, the seed produced under intercropping conditions could fulfill the minimum seed certification standards, accepting a few treatments where the beet leaf crop was also involved in seed production with onion crops.

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