



Report

‘Sufola palong-1’-a new high yielding spinach variety for vegetable growers

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Abstract

Considering the huge demand of a high yielding spinach variety in the market; ‘Sufola palong’- an improved quality spinach variety has been developed at BRAC Agricultural Research & Development Centre through selection. It is a very fast growing high yielding spinach variety and fresh spinach can be harvested within 36-37 DAS. This excellent quality spinach has high vigour, broad thicker soft tastier leaves with nice flavour and also has a very good uniformity rate. Since the yield of this improved quality spinach is much higher than the traditional variety (20-22 Mt/ha) and seed production performance of the newly developed spinach variety is excellent Bangladeshi vegetable growers are now cultivating ‘Sufola palong’ regularly with good enthusiasm and earning a huge profit by growing this novel variety. This high yielding spinach variety can also be grown in the summer season as well. Besides normal harvesting, its leaves can be harvested sequentially following cut-and-come-again method and its high quality leaves can be harvested 3-4 times from the same plot from one time sowing of seeds in the early part of the season. Good quality seeds can also be harvested from these excised plants if these regrown plants are allowed to maintain after bolting.

Keywords: New spinach variety, Sufola palong-1.

INTRODUCTION

Spinach is one of the most important nutritious leafy vegetable generally grown in Bangladesh during the rabi season or winter season and it is a very popular tasteful leafy vegetable in this South East Asian country. Spinach is also a rich source of fiber, vitamins, minerals, antioxidants, bioactive compounds and other nutrients (Bergquist *et al.*, 2005, Miano 2016). Originating in ancient Persia the introduced traditional type of spinach is being cultivated in the Indian subcontinent by the vegetable growers as a common vegetable from the very earliest period although a new red type of spinach has been developed at BRAC Agricultural Research & Development Centre (BARDC) very recently (Biswas 2018, Biswas 2013, Schereinemachers *et al.* 2015). Spinach is also cultivated here in Bangladesh in the homestead gardens with other winter vegetables and mostly it is consumed in the cooked form as delicious preparations. It also requires less amount of energy for its cooking and saves a significant quantity of energy unlike

other kinds of leafy vegetables. Spinach is a very short duration vegetable (Ninfali and Bacchioca 2004) and suitable size spinach can be harvested as early as from 30-35 days after the sowing of seeds. Spinach cultivation is very easy and requires relatively low investment due to its shorter crop duration and minimum requirement of plant protection measures and other inputs as well. It is also a very suitable crop for the refugees and this short duration leafy vegetable can provide nutritious vegetable to these migrant helpless people within a very short span of time. One of the peculiarities of the spinach is that up to 3 to 4 seedlings are emerged from a single dry fruit (actually commercial ‘Spinach seed’s are dried fruits which contain several seeds) which usually helps the farmer to ensure the establishment of a good crop. Although there are different types of spinach varieties viz, smooth leaved, crinkle leaved, round leaved, semi round leaved, pointed leaved, ‘Savoy’ type etc.; in Bangladesh semi round and round smooth leaf type are

generally cultivated and the lion portion of the spinach is grown in the winter season despite the recent availability of a very few all season type varieties. But extreme late rabi season sown spinach normally loses its characteristic flavour and eating quality (Azad *et al.* 2005) although individual varietal characteristics and cultural practices largely controls the nutritional quality of the spinach (Arts and Hollman 2005). Since it is a short duration leafy vegetable, commercial cultivation of spinach is very profitable and there is a huge demand of good quality spinach in the domestic and foreign market as well. But the local varieties which are usually grown by Bangladeshi farmers are inferior type, slow growing, poor yielder and exhibits early bolting characteristics besides their disease susceptibility particularly at the flowering stage. Due to early bolting nature of the traditional spinach variety the farmers faces problem in marketing of this leafy vegetable while a delayed bolting variety not only ensure a good vegetative growth for a better quality spinach it also offers grower a good scope for sequential harvesting and the most amazing fact is that more than

one harvest can be ensured from this type of spinach following *cut-and-come-again* technique (Biswas 2012). From our observation at BARDC it has been found that a BRAC developed late bolting type spinach variety can be grown almost throughout the year successfully (as early as August sowing crop and also as late March sowing crop) and maximum profit can be obtained from its extra early, off season cultivation (sowing of seeds in the middle or in the last week of March) when there is scarcity of leafy vegetables in the kitchen market i.e. in the summer season. Commercial seed production of this vegetable is very rare although there is a good demand of spinach seed among the vegetable growers and as high as 100gm of seeds can be obtained from an ideal mature spinach plant grown in a suitable environment. Since spinach responds very well to selection (Guzhov 1981) and as there is a good possibility of the development of high quality of improved F₁ hybrid spinach variety a spinach-breeding programme was started at BARDC with an objective of the improvement of this delicious leafy vegetable.

Breeding history of ‘Sufola Palong-1’:

Year	Activities	Outcome
2001-02	Germplasm collection & evaluation. Selection of desirable type of spinach plants and selfing.	Several spinach germplasms (total no. of germplasms = 15) were collected from farmer's field or other sources and their accession no. was given accordingly. These germplasms were evaluated in the experimental plots of BRAC Agriculture Research & Development Centre and were characterized. During the evaluation process at pre-flowering stage few robust unbranched late bolting plants (7 plants from the accession no. SP001) with excellent vigour and larger leaves were uprooted from the plot and were planted in a separate plot maintaining isolation distance. At the flowering stage these plants were selfed through bagging. At the time of harvesting, seeds from seven plants were bulked and preserved for next year observation.
2002-2003	Sowing of selfed seeds and raising pure genetic stock (S ₁ generation).	Selfed bulk seeds were sown in the experimental plots of BARDC (1 decimal of land) and standard spinach cultivation practices were provided to raise healthy seedlings. Seed germination was excellent and when the plants reached at 45-46 days - a good variation in vigour, plant size, leaf type and in the nature of bolting was observed in this plant population. Now again 300 robust type late bolting unbranched type plants with larger size semi round shaped leaves were selected and transplanted in a separate nursery plot keeping the distance from row to row 45 cm and plant to plant 30 cm. Necessary cultural practices were provided to facilitate seed production of these high quality spinach plants. At the bolting stage again critical observations were carried out in the nursery plot and off type inferior quality plants were uprooted from the plot to raise more uniform population of healthy plants. After harvesting seeds of these desirable type plants were bulked and preserved for raising next generation.
2003-2004	Pre sowing seed grading and generation advancement (S ₂ generation).	Seeds collected from plants of S ₁ generation were subjected to grading into 2 categories: a. <i>large seeded group</i> & b. <i>small seeded group</i> . Seeds of both the groups were sown on 28.12.03 on separate plots and as the quality of spinach plants belonging to the large seeded group were better, inferior quality off type plants from large seeded group were eradicated through rouging so that pure genetic stock of uniform plants can be raised. At the harvesting stage seeds were harvested from the S ₂ plants were in 2 different ways; a. 10 different normal type healthy plants having small size seeds were selected and these plants were designated as P ₁ , P ₂ , P ₃P ₁₀ accordingly and brought to threshing floor for collecting seeds. Now the entire seed stalk from each plants were cut into 2 pieces and seeds were collected separately from the lower portion and upper portion of the stalk and preserved carefully for next season sowing. On the other hand, b. seeds from the rest of the plants were bulked and preserved for their normal multiplication.
2004-2005	Sowing of the seeds collected from lower portion of the 10 selected plants(S ₃ generation)	Seeds collected from lower portion of the stalk of selected 10 plants were sown on 31.10.04 in plant into rows method in 2 decimal of land keeping the distance between rows 45 cm. Necessary cultural practices were provided to raise healthy plants. At the seedling stage, young plants were thinned to provide sufficient space between the successive 2 plants for ensuring better growth & development of each and every plant. Critical observations were carried out regularly to find out any variations among the progenies derived from each of the 10 plants. At 45-46 DAS clear variations among the progenies of 6 different families out of 10 were noticed and interestingly there were no variations within the progenies of each family. Finally, progenies of 10 plants were grouped into 6 lines; <i>Leafy type</i> (progenies of P ₃), <i>Rosette type</i> (progenies of P ₅), <i>Bunchy type</i> (progenies of P ₇), <i>Biggest type</i> (progenies of P ₃), <i>Erect type</i> (progenies of P ₁), and <i>Normal type</i> (progenies of P ₆ , P ₉ & P ₁₀). The 50 days old plants of each category were then transplanted separately

		maintaining isolation distance to collect seeds of the each lines. At harvesting period seeds from each 6 lines were collected separately and preserved carefully.
2005 -2006	Preparation of <i>Blend-1</i> & <i>Blend-2</i> stock and their evaluation	In this particular step of variety development, seeds of 4 promising lines (<i>Erect type</i> , <i>Biggest type</i> , <i>Bunchy type</i> & <i>Leafy type</i>) were mixed in equal proportion to constitute the ' <i>Blend-1</i> ' stock while mixing seeds of only 2 lines i.e. <i>Biggest type</i> & <i>Leafy type</i> ' <i>Blend-2</i> ' stock were prepared. In the 'Rabi season, seeds of ' <i>Blend-1</i> ' and ' <i>Blend-2</i> ' were evaluated in the experimental plots of BARDC with 2 replications. Between the 2 improved stocks ' <i>Blend-1</i> ' performed better than ' <i>Blend-2</i> '.
2006-2007	MLT & Release of variety	As a pre requisite step of the variety development process Multi Locational Trial (MLT) of <i>Blend-1</i> was completed successfully and finally this Advance line was released as ' <i>Sufola Palong-01</i> ' for commercial cultivation.

Main characteristics of Sufola Palong-1 (Fig.1,Table. 2&3)

- Early season type fast growing and uniform variety.
- Vigorous plant having larger thick, smooth, relatively soft dark green leaves.
- Broad petioled plants become leafy rapidly with beautiful appearance within just 25-30 days.
- Slower in bolting than traditional type variety (bolting starts at 47- 48 DAS) and extra early season sowing delays bolting which ensures the grower marketing of spinach for a longer period.
- Average leaf length is around 38-39 cm. and leaf width is 17-18 cm. Plant wt./plant is around - 212- 213 gm.
- High quality, nice flavoured & tasty spinach.
- It can also be cultivated profitably in the extra early season and then it can be sold at higher price.

- Seed production is also profitable as seed yield/plant is around 70-80gm/plant.
- Tolerant to major disease and insect attack.
- Its leaves can be harvested through cut-and-come-again method.
- It can also be cultivated in the off-season.



Fig.1. '*Sufola Palong-1*' in the field



Fig.2. Plants of '*Sufola Palong-1*'

Table.1. Important plant characters of newly developed different lines of spinach.

Name of the lines	Plant height (cm)	No. of branches/ plant	Seed yield/plant (gm)	Crop duration	Remarks
<i>Leafy type</i>	211.80 ± 7.22 (200 - 218)	3.60 ± 0.89 (3 - 5)	86.40 ± 43.71 (40 - 152)	117.00	Lettuce like plant architecture with prominent big size leaves (Fig. 5).
<i>Rosette type</i>	198.40 ± 36.14 (172 - 300)	3.60 ± 1.14 (2 - 5)	68.80 ± 23.34 (44 - 106)	117.00	Plant had droopy leaves with relatively longer petiole and leaf margins were wavy (Fig. 4).
<i>Bunchy type</i>	154.40 ± 39.25 (111 - 187)	3.40 ± 0.55 (3 - 4)	68.80 ± 22.02 (40 - 96)	108.00	Bushy type plant appearance at marketing stage.
<i>Biggest type</i>	218.80 ± 5.59 (212 - 224)	3.60 ± 1.67 (1 - 5)	85.20 ± 32.02 (50 - 136)	110.00	Bigger size plants at marketable stage(Fig. 3).
<i>Erect type</i>	218.20 ± 14.46 (200 - 240)	3.40 ± 1.82 (1 - 5)	54.40 ± 14.25 (40 - 76)	110.00	Upright type compact plant.

<i>Normal type</i>	213.20 ± 13.55 (190 - 233)	2.70 ± 1.57 (1 - 5)	59.60 ± 20.61 (40 - 102)	118.00	Ordinary type plant.
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Performance evaluation of ‘Sufola Palong-1’ spinach:

To assess the performance of *Sufola Palong-1* an experiment was laid out in BRAC Agricultural Research & Development Centre (BARDC). Seeds of *Sufola Palong-1* (Figs. 1, 2 & 6) along with 3 check varieties viz., *Local*, *Sathi* and *Evan* were sown on 08.10.06 in 4 decimal of land. Besides the *Local* variety, all the other 3 varieties exhibited excellent germination and seedling emergence. Standard cultural practices were provided to ensure better growth and development of each and every plant. It can be mentioned here that the plants of *Sufola Palong-1* grew rapidly compared to other varieties. At 45 DAS plants all the 4 varieties reached at marketable stage and relevant data were collected accordingly and the performance of these 4 varieties have been presented in the Table.1 (Fig. 1 & 2). *Sufola Palong-1* grew faster than all the other 3 varieties and it recorded highest values in all the characters studied (Table.2). Table.1 shows that, at the marketable stage plant height of *Sufola Palong-1* was 60.79% higher than ‘*Local*’ variety and 34.61% and 62.79% than other 2 commercial varieties ‘*Sathi*’ and ‘*Evan*’ respectively. In case of no. of leaves/plant, *Sufola Palong-1* produced 15.53 leaves per plant which is 50.29% higher no. of leaves than ‘*Local variety*’ and 59.68% increased no. of leaves than the other 2 commercial varieties. Significant increase in the length as well as width was recorded in the newly developed

BRAC spinach variety (Table. 2). Fresh wt. per plant in *Sufola Palong-1* was recorded as 212.67gm and near about 163.01% increased fresh spinach wt. was recorded in the *BRAC* variety than the ‘*Local*’ variety. This fresh spinach wt. of *Sufola Palong-1* is also 160.62% higher than ‘*Sathi*’ variety and as high as 381.48% increased fresh wt. than the other commercial variety ‘*Evan*’. It is interesting to note that similar increasing trend of dry wt. was also recorded *Sufola Palong-1* (Table.2) when compared with it with other 3 check varieties.



Fig.3. Biggest type



Fig.4. Rosette type



Fig.5. Leafy type



Fig.6. Plants raised from ‘*Sufola Palong-1*’ (at bolting stage)

Table.2. Comparative study of 4 spinach varieties at marketable size (at 47 days after sowing).

Variety	Source	Plant height (cm)	No. of leaves/plant	Length of 3 expanded leaves (cm)	Width of 3 expanded leaves (cm)	Fresh wt./plant (gm)	Fresh wt. of 3 larger leaves (gm)	Plant dry wt.(gm)
<i>Sufola Palong-1</i>	BRAC	42.00 ± 4.0	15.33 ± 4.72	39.21 ± 2.67	16.67 ± 1.86	212.67 ± 39.11	69.67 ± 13.20	13.23 ± 2.41
<i>Local</i>	Chand Seed Co.	26.12 ± 2.16	10.20 ± 1.30	23.97 ± 1.27	9.00 ± 1.34	80.86 ± 23.94	24.84 ± 4.25	5.00 ± 0.87
<i>Sathi</i> (Commercial variety)	Lal Teer Seed	31.20 ± 1.79	9.60 ± 1.14	28.33 ± 1.89	9.67 ± 1.17	81.60 ± 34.33	26.80 ± 5.89	5.10 ± 1.03
<i>Evan</i> (Com-mercial variety)	Lal Teer Seed	25.80 ± 1.44	9.60 ± 2.70	18.19 ± 2.13	8.77 ± 0.65	44.17 ± 14.87	19.12 ± 4.22	2.76 ± 1.02
Mean	-	31.28	11.18	27.42	11.03	104.82	35.11	6.52

Cultivation of ‘Sufola Palong-1’ in the summer season (off season):

Fresh seeds of *Sufola Palong-1* were sown on 04.04.08 in the BARDC experimental plots just after the first shower to raise the off season crop during the summer season. Very good seed germination was recorded and emerged seedlings came out after 3 days of seed sowing. As a part of cultural practice; weeding was done at 14 days after sowing and top dressing of chemical fertilizer was applied after 15 days followed by a gentle irrigation. All the plants grew normally although it was the summer season and within 33 days all the plants became harvestable. There was a very good uniformity in plant

growth and development. Plant characters and yield have been presented in the following table (Table. 3). Finally a good quality of spinach was harvested in this off season and the taste as well as flavour of the summer spinach was very much similar to the spinach grown in the normal season. Yield was good and 17.78 Mt/ha spinach was produced in the summer season which is also a satisfactory performance. It can be mentioned here that in the Gazipur region the first shower usually bring down the high temperature and once the rain started intermittent rain continues up to the very onset of monsoon season which favours the normal growth of spinach in this region.

Table. 3. Plant characters of ‘Sufola Palong-1’ at 33 days after sowing (DAS).

Variety	Total plant length (cm)	Plant height (cm)	No. of leaves/ plant	Length of 3 expanded leaves (cm)	Width of 3 expanded leaves (cm)	Fresh wt./plant (gm)	Fresh wt. of 3 larger leaves (gm)	Yield (Mt/ha)
<i>Sufola Palong-1</i>	46.90 ± 2.54	34.00 ± 2.49	6.50 ± 0.70	31.51 ± 2.21	14.27 ± 1.56	125.60 ± 36.43	59.20 ± 11.44	17.78

Seed production performance of ‘Sufola Palong-1’:

In BRAC, seed production of spinach is well organized and a very high quality spinach seeds are produced. For this purpose ‘Breeder’s seed’ is produced at BARDC with the direct supervision of the respective breeder and this high quality breeder’s seed is sent to BRAC regional seed farm, Meherpur meant for the production of foundation seed. In the regional farm, foundation seed of ‘*Sufola Palong-1*’ is produced in the actual spinach growing season following standard spinach seed production method and maintaining isolation distance. Systematic rouging practices are also followed to eradicate off-type plants (if they are found). After harvesting, seeds from only healthy good quality plants are collected and are used as ‘Foundation seed’. The responsible farm manager usually supervises the whole seed production package. In the next season these foundation seeds are distributed to the progressive

contract growers to produce ‘Certified Seed’. At the field level certified seeds are also produced with much care under the supervision of BRAC field level staffs and direct monitoring of quality control department. Finally high quality certified seeds are purchased from the registered farmers. Seed production record of the last 5 years has been presented in the following table (Table. 3). From Table.3 it is clear that on an average 11.71 metric tons of spinach seeds were produced annually from 24.61 acres of land. Last year i.e. during the year 2017 as high as 14.87 Mt seeds have been produced while in 2016 lowest quantity of seeds were produced. As the seed production performance of ‘*Sufola Palong-1*’ is very good this is why high rate of achievements always realized against the target (Table.4). On an average 475.74 kg of spinach seeds are produced from 1 acre of land and the farmers are very much satisfied with the seed production performance of ‘*Sufola Palong-1*’.

Table. 4. Last 5- years seed production record of ‘Sufola Palong-1’.

Year	Target (kg)	Area covered (acres)	No. of farmers involved	Production (Mt)	Achievements (%)	Average production/ha (kg)
2014	15,000	21.00	19.00	14.41	96.04	
2015	20,000	28.41	30.00	13.20	65.99	1175.07
2016	20,000	27.76	40.00	8.27	41.34	

2017	15,000	29.49	38.00	14.87	99.11
2018	10,000	16.40	16.00	7.80	78.00
Mean	16,000	24.61	28.60	11.71	76.09

CONCLUSION

Since spinach is a very common winter leafy vegetables of Bangladesh and can be easily cultivated, Bangladeshi marginal and small farmers usually grow it in the early part of winter season to sell their vegetables in the early market for realizing maximum profit. Moreover, as Bangladesh is a flood prone country, short duration vegetables like spinach has a great significance for the people of the flood affected areas. In those areas, after receding flood water flood victims usually grow short duration vegetables so that they can harvest vegetables earlier for selling these vegetables in the market for earning money or can be used for home consumption. Again spinach is being widely cultivated in Bangladesh in the homestead areas by the health conscious village people to consume safe nutritious vegetable as well. Off season cultivation and roof top cultivation of spinach has also become a new trend of vegetable cultivation in Bangladesh by the progressive and fancy type of vegetable growers. For off season spinach cultivation, farmers usually grow spinach in the later part of the summer season (sowing period last week of March to middle of April). So, it appears that BRAC developed improved new spinach variety will find a special market as this spinach variety is a very fast growing high yielding spinach with good nutritional quality.

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