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RESEARCH PAPER

Seed yield, incidence of yellow vein mosaic virus and economic viability of okra seed crop as influenced by staggered sowing in South- western Punjab

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Abstract : Investigations were carried out in South-western district of Punjab in Indo-Gangetic plain region during four consecutive years to work out the most suitable sowing time to achieve higher seed yield and comparatively less incidence of yellow vein mosaic virus (YVMV) in okra. The sowing of okra was staggered from May 1 to June 15 at fortnightly interval. The results revealed that seed yield differed significantly with different sowing dates. The highest seed yield was observed in crop sown on May 1, followed by crop sown on May 15 but further delay in sowing to June 15 through May 30 resulted in progressive and significant reduction in seed yield of okra. The higher seed yield under earlier sowing can be ascribed to less incidence of YVMV, which was higher under late sown conditions. The income per rupee investment of okra seed crop was found to be the maximum (5.31) when sown on May 1.

Key Words : Okra, Sowing dates, Seed yield, YVMV

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INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] - one of the world's oldest cultivated crops is believed to have Indo-Burma origin (Zeven and Zhukovsky, 1975) and Africa origin (Thomson and Kelly, 1979). The special taste and nutritional value of this crop had attracted more attention in some tropical and subtropical areas of the world (Kochhar, 1986). It plays an important role in meeting the demand for vegetables in our country where vegetables are scanty in the market. It is said to be "a perfect villager's vegetable" (Adamou *et al.*, 2010 and Holser and Bost, 2004). It is an important source of carbohydrates, minerals, amino acids which play a vital role in human diet (Gopalan *et al.*, 2007; Farinde *et al.*, 2007; Dilruba *et al.*, 2009 and Saifullah and Rabbani, 2009). It has good nutritional value, particularly the high

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content of vitamin C (30 mg/100 g), calcium (90 mg/100 g), iron (1.5 mg/100 g) and other minerals like magnesium and potassium, vitamin A and B, fats and carbohydrates (Aykroud, 1963). Tender fruits are used as vegetables or in culinary preparations as sliced and dried pieces. It is also used for thickening gravies and soups, because of its high mucilage content. The roots and stems of okra are used for cleaning cane juice (Chauhan, 1972). Matured fruits and stems containing crude fibre are used in paper industry.

One of the important limiting factors in the cultivation of okra is insect pests. Many of the pests occurring on cotton are found to ravage okra crop. As high as 72 species of insects have been recorded on okra (Srinivasa and Rajendran, 2003), of which, the sucking pests comprising of Aphids, *Aphis gossypii* (Glover), leafhopper/jassid, A*mrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and mite, *Tetranychus cinnabarinus* (Boisduval) cause significant damage to the crop. Krishnaiah (1980) reported about 40 to 56 per cent losses in okra due to whitefly and leafhopper.

There is a reduction of 49.8 and 45.1 per cent in height and number of leaves, respectively due to attack of pests (Rawat and Sadu, 1973). Okra crop is susceptible from early stage to maturity. Among the wide array of insect pests infesting okra crop, the sucking pests which are, aphid, *A. gossypii* (Glover), leafhopper (*A. biguttula biguttula* (Ishida) and whitefly, *B. tabaci* (Gennadius), were reported to be quite serious during all stages of the crop growth (Channabasavanna, 1981 and Singh *et al*., 1987). Whitefly (*B. tabaci*), the milky white minute flies; nymphs and adults suck the cell sap from the leaves. The affected leaves are curled and dried. The affected plants show a stunted growth. Whiteflies are also responsible for transmitting yellow vein mossaic Virus. Heavily infested leaves turn yellow, get deformed, curled and dried up causing serious reduction in fruit yield. Besides, causing direct losses, it is capable of transmitting viral diseases on different host plants (Butani and Verma, 1976). In order to prevent the losses caused by insects and to produce quality crop, it is essential to manage the pest population at appropriate time with suitable measures. The multiplication of these pests has been found to be favoured by environmental factors. Insecticides are the only options for the vegetable growers to manage insect pests in the developing countries. Indiscriminate use of pesticides leads to an undesirable load of pesticide residues in saleable vegetables (Kumar and Singh, 2002). It is necessary to explore alternative methods to reduce the use of pesticides and their adverse effects on the environment and human health. Altering the date of sowing along with rational use of insecticides can help a great deal in this regard.

Among the various agronomic practices, the time of sowing is an important factor affecting the yield, quality and disease incidence of crop by way of changed climatic variables during the life cycle of crop plant. Sowing time has a great impact on seed production of okra and time of sowing has a direct bearing on the incidence of YVMV disease in eastern India (Yadav and Dhankar, 2001 and Moniruzzaman *et al.*, 2007). Hence, sowing time may affect the crop yield due to occurrence of various abiotic and biotic stresses particularly yellow vein mosaic virus (YVMV).

Tindall (1983) and Nonnecke (1989) concluded that seed can geminate in relatively warm soils, no germination occurs below 16°C and mean temperature range of 21 to 30°C is considered ideal for growth, flowering and pod development. Early planting gives the longest growth cycle. Early okra planting may face cool conditions and late planting may suffer from high virus infestation. Yellow mosaic virus disease is the most serious problem for okra cultivation. All locally grown recommended varieties of okra are susceptible to this disease. The disease YVMV transmitted by the whitefly (*Bemisia tabaci*) is reported to be one of the most destructive plant diseases in India causing great loss by affecting quality and yield of fruits, as high as 93.80 per cent depending on age of plant at the time of infection (Sastry and Singh, 1974).

Available reports suggest that planting date plays an important role in plant growth, fruit development, seed yield and its quality in okra. The early sown crop in rainy season experiences high temperature and hot winds during their growth period resulting in stunted growth, less number of fruits and reduced seed yield. The late sown crops encounter high rainfall during flowering and fruit set are more prone to attack by insect-pests and diseases. Therefore, it was imperative to find an ideal time for sowing of okra seed crop to get economical returns.

The recommended sowing time of okra for seed production in Punjab is 2nd fortnight of June. The seed crop of okra sown during 2nd fortnight of June generally matures in 90-100 days and the flowering starts 40-45 DAS, which co-incide with last week of July. This reproductive flush has to endure the attack of jassid and whitefly due to prevalence of cloudy weather conditions at that time, resulting into drastic reduction in seed yield. Therefore, proper and suitable date of sowing is critical for seed production of the crop. The information available so far regarding suitable sowing time for okra seed production is inadequate under the Punjab conditions. Hence, field investigation was carried out to find out the most suitable sowing time to achieve higher seed yield of okra.

Material and Methods

The field experiments were conducted during *Kharif* 2012 - 2015 at the seed production farm of Krishi Vigyan Kendra, Faridkot (30°63' N latitude, 74°82' E longitude and an elevation of 210 metres above the mean sea level), India. Faridkot has sub-tropical and semi-arid climate with cold winters and hot-dry summers. The soil of experimental site was sandy loam in texture having pH 7.5. The field experiment was laid out in Randomized Complete Block Design (RCBD) with 4 sowing dates (D_1-May 1, D_2-May 15, D_3-May 30 and D_4-June 15). The variety under question was Punjab 8. The plants of this variety are medium tall with splashes of purple pigmentation present on the stem. Leaves are deeply lobed and less serrated. Leaves, stem and petiole are less hairy. Fruits are thin, long, dark green and five ridged.

For seed production of okra, minimum isolation distance of 200 metres between two cultivars was followed. It required a seed rate of 5-6 kg/acre which was sown on flat soil maintaining a distance of 60 cm and 25 cm between rows and plants, respectively. A minimum of three field inspections were conducted to produce true to type seed. The first inspection before flowering, second at flowering and fruiting and third before harvesting of the crop. The off type and diseased plants were rogued off. The seed crop matured in 90-110 days. The pods were picked 3-4 times due to uneven maturity. The harvested pods were dried in the sun threshed and the seeds were cleaned.

The crop was applied 36 kg of N (80 kg of urea) per acre. First half of the N was applied at sowing and the rest one month, thereafter. To keep weeds under control, three to four hoeings were given. The first hoeing was given when the seedlings were two weeks old and subsequent hoeing at fortnightly intervals. Besides this, Stomp 30 EC (pendimethalin) 1.0 litre/acre was sprayed within two days of sowing. First irrigation was given after 5 days of sowing. Further irrigations were given after 10 days. Total 10 irrigations were given. For control of jassid and spotted bollworm, 8 kg Thimet 10G (Phorate) was applied at sowing in furrows. Subsequent sprays with 250ml rogor 30EC (dimethoate) and 20 g pride 20 SP (acetamiprid) in 100-125 litres of water/acre were applied alternately. To control whitefly (the virus vector), crop was sprayed with 560ml of malathion in 100-125 litres of water/acre.

The disease intensity of the experimental plots was measured by counting the number (%) of yellow vein mossaic virus infested plants at different days. Net returns per hectare were calculated by subtracting cost of cultivation from gross returns under particular sowing date. The benefit cost ratio (B: C ratio) was calculated by dividing the gross returns by cost of cultivation in the system.

The treatment means were separated by critical difference (CD) at 5 per cent level of significance for better interpretation of the results as advocated by Gomez and Gomez (1984).

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Seed yield and incidence of YVMV :

The seed yield of okra differed significantly with sowing dates (Table 1). There was progressive and significant decline in seed yield of okra with delay in sowing. Maximum seed yield was recorded in crop sown

Table 1: Effect of sowing dates on seed yield (q/ha) of okra (Var. Punjab 8)

Sowing date	2012	2013	2014	2015	Mean
May 1	12.75	10.75	13.05	13.38	12.45
May 15	12.53	10.50	12.38	12.75	12.03
May 30	7.55	7.50	8.88	8.30	8.05
June 15	4.30	4.20	5.13	5.03	4.68
C.D. (P=0.05)					0.28

on May 1 (12.45 q/ha) followed by May 15 sowing (12.03 q/ha). Both of the treatments recorded significantly higher seed yield than the rest of two treatments, *i.e.*, crop sown on May 30 and June 15. The respective seed yield was 8.05 q/ha and 4.68 q/ha in crops sown on May 30 and June 15. The data indicate that there was progressive decline in seed yield with the delay in sowing. It has been observed that seed crop of okra, generally, matures in 90-100 days and the flowering starts 40-45 DAS. The observations over the period indicated that when sowing is done in the second fortnight of June, flower initiation occurred in the last week of July. The cloudy weather conditions prevailing at that time favored the buildup of jassid and whitefly population. Hence, that reproductive flush had to endure the attack of jassid and white fly resulting in drastic reduction in seed yield. However, in early sown crop, by the time, jassid and white fly population build up was beyond ETL, the crop was 60 days old. The crop had three flowering flushes and was able to bear the pest attack. The results of present study were found in consonance with those of Akinyele and Osekita (2006) and Moniruzzamam *et al.* (2007).

The seed yield of okra was highly influenced by the incidence of YVMV (Table 2) and higher yield was obtained under early May sown conditions. Delayed sowing on May 30 and June 15 recorded significantly higher incidence of YVMV (%), *i.e.*, 22.8 per cent and 29.1 per cent, respectively, resulting in significant reduction of seed yield as compared to early sown crop. This was due to the fact that there was upsurge in whitefly population as the sowing was delayed. Whitefly infestation commenced in 25th standard meteorological week and there was a progressive increase in incidence of whitefly, thereafter, due to favourable climatic conditions prevailing at that time. The peak period of activity was found to be between 28th – 39th Standard meteorological weeks. It was observed that when sowing was done in the second fortnight of June, flower initiation

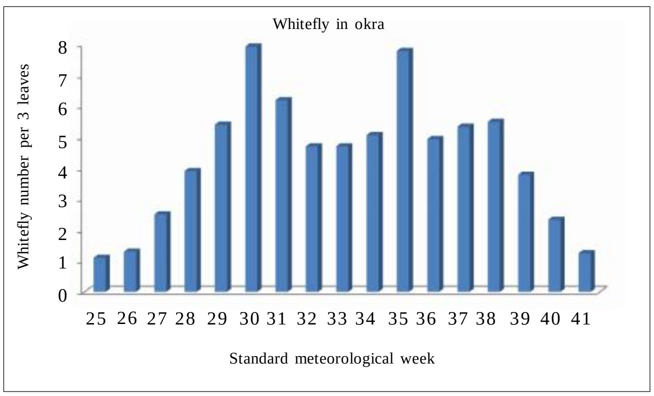

Fig. 1 : Incidence of whitefly in okra var. Punjab 8

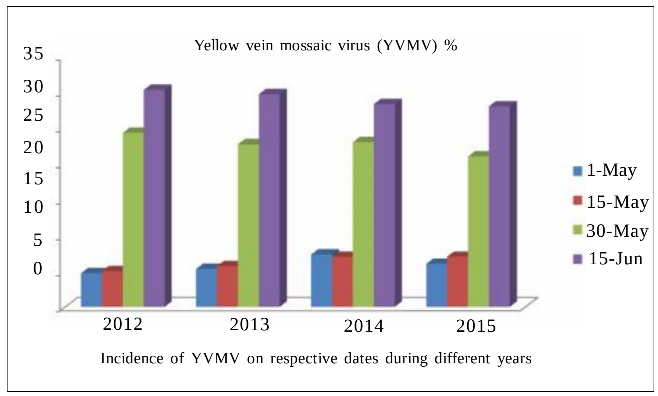

Fig. 2 : Incidence of yellow vein mossaic virus in okra var. Punjab 8

Table 2 : Effect of sowing dates on incidence of yellow vein mossaic virus (%) in okra (Var. Punjab 8)

Sowing date	2012	2013	2014	2015	Mean
May 1	4.7	5.3	7.3	6.0	5.8
May 15	5.0	5.7	7.0	7.0	6.2
May 30	24.3	22.7	23.0	21.0	22.8
June 15	30.3	29.7	28.3	28.0	29.1
C.D. (P=0.05)					0.89

Table 3: Economic analysis of staggered sown okra (Var. Punjab 8) for seed production

Sowing date	Gross returns (Rs./ha)	Variable cost (Rs./ha)	Net returns (Rs./ha)	B:C
May 1	2,49,000	46,875	2,02,125	5.31
May 15	2,40,500	50,500	1,90,000	4.76
May 30	1,61,000	53,800	1,07,200	2.99
June 15	93,500	54,375	39,125	1.72

occurred in the last week of July. The cloudy weather conditions prevailing at that time favoured the build up of whitefly population. Hence, that reproductive flush had to endure the attack of whitefly resulting in drastic reduction in seed yield. Threhan (1944) also reported that cloudy weather, high temperature and low rainfall were found to favour the rapid multiplication of the pest. The same results were reported by Ozgur *et al*. (1990); Rao *et al*. (1989); Preetha and Nadarajan (2007) and Hegde *et al*. (2004).

The data recorded for jassid population (Fig. 3) revealed that jassid has become the major pest in okra over the last few years even surpassing whitefly, thereby, substantially contributing to reduction in seed yield in late sown crop. Jassid infestation commenced from 25th standard meteorological week and the peak was observed between 29th-36th standard meteorological weeks. These findings are in agreement with the reports of Narangalkar (2003) and Senapati and Khan (1978).

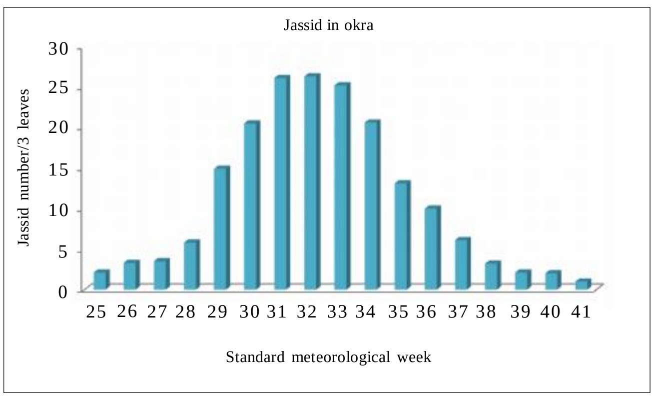

Fig. 3 : Incidence of jassid in okra var. Punjab 8

Economics :

The economic analysis revealed that seed production of okra was found to be more remunerative when crop was sown upto mid May as indicated by higher net returns and profitability as well as B:C as compared to late sowing. The net returns of okra seed crop was found to be the maximum (Rs. 2,02,125/ha) when sown on May 1 followed by May 15. (Rs. 1,90,000/ha) and it was least in case of June 15 sown crop (Rs. 39,125/ha). So, it can be concluded that sowing of okra for seed production should be planned in the early May for higher seed yield and net returns (Table 3).

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