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Effects of Seed Quality on Plant Population and Seed Yield of Double Cropped Soybean in the Mediterranean Region of Turkey

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Abstract: A two-year field study was conducted to determine the effects of different seed quality on plant stand and seed yield. Mixing dead seeds ranging from 5 to 50% into high quality seeds, eleven different seed qualities were created. The study was planted in the experimental field of Cukurova University on a silt loam soil in a Randomized Complete Block Design with three replications. Dead seed rate had significant affect on the number of plant per hectare. The highest plant population was obtained from no dead seed added treatment and the lowest was obtained from 50% dead seed added treatment in both years. Pod number and seed number per plant increased with the decreasing number of plant per hectare. Seed yield was positively correlated with seed quality and number of plant per hectare. The highest seed yields were obtained from 10% dead seed added treatments with the plant densities of 128900 and 127864 ha^{-1} in 2003 and 2003, respectively. Seed yield increased with the increasing plant density upto a maximum level and declined when plant density was increased further. Results showed that use of high quality certified seeds are required to obtain adequate plant number per unit area for maximum yield. It is recommended that certified seed must be used to reduce the risk of stand establishment failure to ensure full seed yield.

Key words: Soybean (*Glycine max* L.), seed quality, stand reduction, seed yield, double cropping

INTRODUCTION

Uniformly distributed an optimum stand is necessary to achieve a full canopy for maximum seed yield because of shorter plant height and less vegetative growth under double crop conditions. Poor seed quality, whether physical, physiological or pathological causes, may seriously reduce stand reduction due to the low germination compared with high quality certified seeds. As the production cost increase, some of the growers use homegrown seeds to reduce cost of production. However, farmer retained home grown seeds have low germination rate, high inner matter (hulls, straw, stones and weed seeds), diseased and damaged seeds because of improper harvesting, storage and processing[1-5].

Stand reductions are often a serious problem in farmer retained seed planted fields. Soybean plant can tolerate some variation in stand reduction. Soybean stand has a tremendous ability to compensate for missing plants by developing branches to occupy the space. If the gaps within rows are small the impact of stand reduction on seed yield is low. Optimal plant population varied from 30 000 to 500 000 plants ha^{-1}[6-15]. As plant population increase, plant height and lodging tend to increase.

Both the number and the distribution of the plant per land area are important for maximum seed yield. Uniform and uneven distribution of stand reductions differently affect soybean seed yield. Vasilas *et al.*[16] reported an average of 4% seed yield decrease at the 33% stand reduction imposed both uniformly and unevenly. However, same researchers obtained much higher seed yield reduction at the 66% stand reduction imposed unevenly than the same level of stand reduction imposed uniformly. Willmot *et al.*[17] reported 10.8 and 21.1% yield reductions at the 40 and 60% randomly imposed stand reductions, relative to uniform stands, respectively. Unlike other stand reducing factors, stand reduction caused by poor seed quality is more uniform across the field. Therefore, seed yield reduction may not be high at the stand reductions caused by poor seed quality. Adjusting plant population with the use of poor quality seed is very difficult, yield reductions occurs above or below a certain level of plant population. The purpose of the current study was to determine the effects of various levels of

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dead seed containing seed lots (seed quality) on plant population and seed yield of double cropped soybean.

MATERIALS AND METHODS

Field experiments were conducted in 2002 and 2003 at the experimental field of Cukurova University, Turkey. The soil was a clay silt loam with pH of 7.5, 0.8% organic matter and water holding capacity of 0.34 cm^3. Fertilizer was applied prior to planting at a rate of 36-92-0 kg NPK ha^{-1}. Recommended practices were used for weed and insect control. The experimental design was Randomized Complete Block with 3 replications. The seeding rate was approximately 20 seeds per linear m of row in both years.

Before planting, germination ability of certified seed of soybean cultivar Asgrow 3935 was determined according to the Association of Official Seed Analysts[18]. Three replications of 100 seeds were placed in presoaked germination paper and were then placed in a seed germinator at 24°C for 7 days. After 7 days, the percentage of seeds germinating was recorded.

Seeds of soybean cultivar Asgrow 3935 were kept at 70°C in an oven for 24 h to loose viability. Certain amounts of dead seeds were mixed with high quality certified seeds to obtain 11 different seed qualities, ranging 5 to 50% dead seed. No dead seed added high quality seeds were used as control. Seeds were machine planted on 15 June 2002 and 14 June 2003 after wheat harvest. Experimental units consisted of four row plots having a row length of 6 m and row width of 0.65 m. Before harvest, the two center rows were end trimmed to final length of 5 m to determine seed yield. In both years, seed germination and plant emergence were helped by light sprinkler irrigation. Flood irrigation method was applied every 15 days interval. Trifluralin was applied at the rate of 1200 g ha^{-1} pre-sowing to control annual weeds. After emergence weeds were controlled with hoe or rotovator in each year. Ten plants were harvested at maturity from first and fourth rows of each plot to measure plant parameters.

Measured plant parameters data were subjected to analysis of variance using the general linear models procedure in the Statistical Analysis System[19]. Means of measured plant parameters were compared by using Fisher's protected Least Significance Difference at 95% probability level.

RESULTS AND DISCUSSION

Number of plants per hectare was significantly affected by the percent dead seed rate (seed quality). The highest plant population was obtained from no dead seed added control treatment and the lowest was obtained from 50% dead seed added treatment in both years (Table 1). Number of plants per hectare decreased with the increasing dead seed rate.

Pod and seed number per plant are the most variable of the seed yield components in response to changes in plant density. Pod and seed number per plant negatively correlated with number of plant per hectare. Decreasing number of plant per hectare increased the number of pod and seed number per plant. Seed and pod number increase in the low populations were the result of extra branching. Soybean seed yield is determined by the number of plant per hectare, number of pod per plant, number of seed per plant and seed weight. In the current study, number of branch, number of pod and seed were negatively correlated with seed yield. Since at low populations, seed yield decreased while branch, pod and seed number per plant increased. At low populations, Existing plants developed more branches and pods because of reduction in competition. When seed yield was in consideration, the highest seed yield was obtained from 10% dead seed added treatments with 3219 and 4231 kg ha^{-1} in 2002 and 2003, respectively. Number of plants in control and 5% dead seed added plots exceeded the maximum plant number for maximum seed yield. The seed yield reductions in these two treatments were resulted from plant number not the dead seed rate. Plant competition and lodging were the main cause for seed yield reduction in control and 5% dead seed added treatments in either year. The densities between 125 000 and 130 000 plant ha^{-1} were optimum (100% of yield potential) for double cropped soybean in the region. Seed yield reduction is inevitable if the number of plants per hectare is above or below these limits. Reduced seed yield was reported as a result of the use of low quality seed[20,21]. However, no relationship was found between seed quality and seed yield when adequate plant population was supplied by planting with different seed quality[20,22,23]. These researchers suggested that use of high quality seeds increases the probability of obtaining required plant populations for maximum yield under a wide range of field conditions. Adjusting number of plant per unit area is very difficult by the use of farmer retained seed. Therefore, yield reduction may occur because of inadequate or excessive plant population. Plant populations ranging from 700 00 to 128 000 ha^{-1} differed in full yield potential by 27%. Soybean stand has tremendous ability to compensate for missing plants. Unlike stand reductions caused by soil crusting, soil moisture extremes, pesticide drift, insects, pathogens and hail damage, stand reductions caused by poor seed

Table 1: Effects of seed quality on plant population, seed yield and yield components of double cropped soybean

Dead seed rate	Plant density 2002-2003		Stand reduction 2002-2003		Branch number 2002-2003		Pod number 2002-2003		Seed number 2002-2003		Seed yield 2002-2003		Yield lost 2002-2003		Yield reduction 2002-2003	
--%--	--------- ha^{-1}--------		------- % --------		--- $Plant^{-1}$----		---- $Plant^{-1}$ ----		----- $Plant^{-1}$----		---- kg ha^{-1}----		-- kg ha^{-1}---		------ %---------	
0	143229	144006	----	----	1.8	1.8	45.6	47.4	105.0	108.9	3056	3909	196	322	5.4	7.6
5	136456	135323	4.7	6.0	1.9	1.9	47.1	48.0	108.4	110.4	3112	4213	73	18	1.6	0.4
10	128900	127864	10.0	11.2	2.0	2.1	48.4	50.6	111.7	116.6	3219	4231	0	0	0.0	0.0
15	121560	123145	15.1	14.4	2.2	2.2	49.3	51.1	113.9	117.6	3105	3994	114	237	3.5	5.5
20	115473	114372	19.3	20.5	2.3	2.3	50.6	52.0	116.9	119.9	2964	3688	255	543	10.2	12.9
25	107929	105789	24.6	26.5	2.3	2.4	51.5	53.4	119.6	123.0	2866	3649	353	582	10.7	13.7
30	100952	101409	29.5	29.5	2.4	2.5	55.0	56.1	127.1	130.2	2745	3551	474	680	14.5	16.1
35	93740	94690	34.5	34.2	2.6	2.6	59.8	61.4	138.8	143.4	2589	3381	630	850	19.3	20.1
40	86296	85351	39.7	40.7	2.7	2.8	60.9	62.9	141.6	147.0	2468	3355	751	876	22.9	20.6
45	78603	76686	45.1	46.7	2.8	2.9	63.8	65.9	148.6	154.5	2434	3246	785	985	24.6	23.2
50	72247	70840	49.5	50.8	3.0	3.3	68.1	70.3	168.5	164.7	2338	3107	881	1124	27.4	26.6
LSD 0.05	1311	1447	0.9	1.9	0.01	0.05	2.1	3.9	1.64	1.65	117	266	443	221	13.4	5.2

quality are more uniform across the field. Therefore, counting the existing stand, estimating the yield lost and replant decision are much easier than the other stand reducing factors.

The results showed that seed yield increased with increasing plant density up to 128 900 and 127 864 plants ha^{-1} in 2002 and 2003, respectively and declined when plant density was increased further. Use of poor quality seeds affects seed yield by reducing final stand due to low germination and low plant vigor. In present study we ignored plant vigor while estimating yield lost, since we used same certified high quality seed lot to create 11 different germination rates by mixing various amount of dead seeds. Therefore, yield lost caused by farmer retained seed is much higher than our findings due to the yield reduction caused by low plant vigor of low quality seed. Since germination percentage and seed vigor may not be related. As seeds deteriorate during the storage, their performance potential and vigor decline before there is any loss in germination percentage[2]. Planting high quality seed increases the probability of obtaining desired plant population under field condition.

Due to high fragility of soybean seed coat, high quality seed should be prepared by careful harvesting, processing and storage to ensure high germination rate and vigor. Only special seed growers under the control of seed industries supply the requirements for high quality seed. None or a few of the farmers have equipped to produce high quality seeds. Therefore, farmer retained seeds exhibits various level of germination rate. Even the germination rate of farmer retained seeds are known, it is not always possible to have desired plant density in an area to have full yield. Under double crop condition, above or below the certain level of plant density caused yield lost depending on the severity of stand reduction or stand exceeding. The result of current study showed that soybean growers must use high quality certified seed instead of farmer retained seed due to varying levels of low germination rates.

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