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Research Article

Enhancing Yield and Nutritive Value of Forage for Livestock Feeding Through Corn Soybean Intercropping Strategy with Several Pre-sowing Soybean Seed Coatings

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ABSTRACT

In attempt to avoid crop damage through wild bird's picking, this study was designed with aim to evaluate several pre-sowing soybean seed coatings for optimum yield in corn-soybean mixed forage. It was investigated under four cropping treatments, *viz*. 1) corn sole, 2) corn mixed with soybean without any coating, 3) corn with iron coated soybean and 4) corn with thiram coated soybean. Each treatment had three replicates and corn sole was control treatment. Pioneer (P1184) and crossbred (PI483463 × Hutcheson) seeds were used for corn and soybean, respectively. The trial was conducted under randomized block design from 5th June to 23rd September, 2015. Data were an alyzed through ANOVA technique using SAS9.1.3 software. Results depicted that survivability of soybean against wild birds damage was found better (p<0.05) in thiram coating which was higher than iron coating and control treatment but later on thiram coating had adverse effects on subsequent growth of soybean plants. Corn stalk height was decreased (p<0.05) in thiram coating, whereas corn ear height was reduced in iron coating treatment. Iron coating enhanced (p<0.05) height of soybean plant (p<0.05) better than that of thiram coating. Soybean seed coatings didn't influence dry matter yield and nutritive value in terms of total digestible nutrients yield in corn soybean mixed forage. Conclusively, although presowing thiram coating enhanced survivability of soybean plants against wild bird damage but had adverse effects on its subsequent growth. However, soybean seed coatings didn't influence yield and nutritive value of corn soybean intercropping forage.

(**Key Words** : Corn-soybean, Intercropping, Iron coating, Thiram coating, Wild bird's damage)

I. INTRODUCTION

Livestock industry plays a pivotal role in provision of valuable livestock products which have become an integral part of people's routine diet in Republic of Korea. This immense demand putts pressure to boost more livestock production and consequently, six livestock products (beef, milk, pork, chicken, eggs and duck) have been already included in top 10 Agro-forestry foods in country (Chung *et al*., 2014). Consequently, livestock population of beef cattle, pigs, chicken and dairy cattle is reached to 2742, 10355, 101014 and 402 thousand heads, respectively during second quarter of year 2016 (KOSTAT, 2016). However, required feeding resources for livestock feeding are not adequately available due to limited cultivatable land and traditional forage production techniques. Farmers usually like maize as basal forage crop for feeding of their livestock due to its high palatability characteristic but it is protein deficient fodder and needs nitrogen for optimum growth.

Mixed sowing maize with soybean as intercropping is getting renowned in farmers community as a promising technique to fetch greater yield under limited land resources (Seo *et al*., 2014). Intercropping does not only enhance forage yield using biculture rhizobial symbiosis (Latati *et al*., 2013) but also enhance soil fertility through nitrogen fixation by leguminous specie (Li *et al*., 2001; Tsubo and Walker, 2002 Awal *et al*., 2006; Zhang *et al*., 2015). Although corn-soybean is revolutionized technique but confronts certain issues including post seeding crop damage by wild bird's picking.

Damage of crops including corn and soybean by wild birds has been well recognized economic problem (Bruggerset *et al*., 1998). A variety of technologies have been utilized in tackling

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this issue forhigh crop performance but seed coating would be an crucial invention which might protect not only seed but also emerging seedling (Turnblad and Chen, 1999). Thiram (tetra-methyl thiuram disulfide) had been used effectively in pre-sowing seed coating programs in rye cultivars and exhibited adequate reduction in feed picking activity of different wild bird species (Falloon, 1980). Keeping in view the salient importance of pre-sowing seed coating, this study was designed with aim to evaluate several soybean seed coatings for optimum yield and nutritive value of corn-soybean mixed forage.

Ⅱ. MATERIAL AND METHODS

1. Location of research site

Research trial was conducted at private farm in Angang-eup Gyeongju-city in Gyeongbuk province of South Korea. Its geographical coordinates are 36°00'51.5"N 129°12'13.5"E. The climate; ambient temperature and total rainfall data of experiment period and last five years is given in Table 1. This data was taken from Korean Meteorological Administration.

2. Experimental treatments

Effect of corn-soybean intercropping with various soybean seed coatings was investigated under threecropping treatments, *viz.* Treatment 1: Corn mixed with soybean without coating (control), Treatment 2: Corn with iron coated soybean and Treatment 3: Corn with thiram coated soybean. Additionally, corn sole was also grown under positive control treatment. Each treatment had 3 replicates. An area of land having length and width measurement (15 × 12 m) was selected and divided first equally into 3 main blocks (replicates); A, B and C and then each block was divided into 4 subplots following randomized block design. A numbers of 12 plots (Each plot: 5 × 3 m) were made available for random application of 3 regular treatments and one positive treatment with 3 replicates in each.

3. Seed coatings

In order to pre-sowing soybean seed coating with thiram, 10 kg soybean seeds were mixed with 30 ml of "Saechong" liquid containing active ingredient 26.5% thiram in the plastic container. After thorough mixing and vigorous shaking, thiram coated soybean seeds was dried under the shade and well ventilated place. Similarly, soybean seeds coating with iron was carried outthrough mixing of 10 kg seeds with iron-gypsum mixed powder (4 kg iron and 1 kg gypsum).

4. Land preparation, sowing and harvesting

The fertilizer N-P-K (21:17:17) was used at the rate 1,000 kg per hectare while preparing land. Seeding was carried out on 5th June, 2015 on 4 lines having interline distance 75 cm in each plot. Varieties of seeds chosen for corn and soybean were Pioneer (P1184) and crossbred (PI483463 × Hutcheson), respectively. Corn seeding was performed in lines keeping corn to corn distance 20 cm followed by soybean seeding on same corn lines with inter seed distance of 10 cm. Mixture of Alachlor and Simazine herbicides was sprayed on land soon after completion of seeding process. Survival of plants was checked on 29th June, 2015, whereas harvesting of crops was made on 23rd September, 2015.

5. Parameters studies

The impact of soybean seed coatings was studied in terms

Table 1. Average temperature and total rainfall in Gyeongju, Gyeongbuk, South Korea

Climate	Year	June	July	August	September	October
Temp (°C)	2015	21.2	21.2	24.0	25.4	19.8
	2010-2014	21.4	25.4	25.3	20.2	14.3
Rainfall (mm)	2015	77.7	224.7	171.6	104.2	37.0
	2010-2014	90.9	170.0	243.8	137.3	82.5

of following parameters; survivability of corn & soybean, corn stalk height & number, corn ear height & number, soybean height & number, corn stalk dry matter yield, corn ear dry matter yield, soybean dry matter yield and total digestible nutrient yield of corn & soybean.

6. Data collection

Height and number of maize stalk, maize ear and soybean weremeasured and counted on harvesting time. Maize height was taken from ground to top of plant and height of maize ear was measured from ground to the bud of ear evolved, whereas soybean height was measured from ground to top of plant. Five plants were taken randomly from each replicate for measuring data regarding height. Similarly, 2 samples from each replicate were randomly taken for dry matter yield, initially weighed, dried in oven at 70° C for 72 hours and then again weighed after drying. The percentage of DM was just calculated using fresh yield and dry matter yield information. Fiber analyses (NDF & ADF) were performed as per procedure of Van Soest *et al*. (1991). Total Digestible Nutrients (TDN) was calculated through following equations (NFTA, 2016),

% TDN = Total Digestible Nutrients
= 4.898 + (89.796 × NEL)

NEL (Mcal/lb) = 1.0876 - (0.0127 × ADF)

7. Statistical analysis

The collected data were analyzed using ANOVA technique (Steel *et al*., 1997) through SAS 9.1.3 software. The difference among three treatment means was tested through Duncan Multiple Range Test.

$$\textbf{Model : } Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$$

Where,

μ is the overall (grand) mean,

α_i is the effect due to the 3 treatments,

β_j is the effect due to the 3 blocks, and,

ε_{ij} is the error term where the error terms, are independent observations from an approximately normal distribution with mean is equal to 0 and constant variance σ^2

Ⅲ. RESULTS

1. Effect of seed coating on survival of corn and soybean plants after wild bird's damage

Number of corn remained after wild birds damage was found similar (P>0.05) among different treatments, whereas number of soybean plants remained was found higher (81.6 ± 1.5a) in thiram coated treatment than that of control (64.3 ± 3.2b) and iron coated treatment (47 ± 5.2c).

2. Effect of soybean seed coating on growth of forage

Response of seed coating is mentioned in Table 2. Seed coatings didn'tinfluence (p>0.05) number of corn stalks, corn ears and soybean but thiram coating reduced height of corn

Table 2. Effect of different soybean seed coatings on growth characteristics of corn and soybean mixed forage (Mean ± SD)

Parameters	Corn with no soybean coating (Control)	Corn with iron coated soybean	Corn with thiram coated soybean
Corn stalk height(cm)	269.7 ± 3.3	264.5	261.9
Corn ear height(cm)	102.0 ± 3.4 a	92.0 b	98.4 ab
Soybean height(cm)	75.5 ± 7.2	95.3	54.2
Corn stalk number(no.)	25.5 ±2.5	26.6 ± 3.3	26.1 ± 6.3
Corn ear number(no.)	25.5 ±2.5	30.0 ± 2.8	23.8 ± 4.1
Soybean number(no.)	19.4 ± 4.19	20.0 ± 4.4	25.0 ± 1.6

[a.b.] Variables having varying superscripts in the same row are significantly different (p<0.05)
SD : Standard deviation

Table 3. Effect of different soybean seed coatings on dry matter yield in corn and soybean mixed forage (Mean ± SD)

Parameters	Corn with no soybean coating (Control)	Corn with iron coated soybean	Corn with thiram coated soybean
Corn stalk DMY(ton/ha)	6.75 ± 1.4	6.25	6.06
Corn ear DMY (ton/ha)	5.00 ± 0.8	5.70	4.69
Soybean DMY (kg/ha)	700 ± 0.3	657	579
Total DMY (ton/ha)	12.46 ± 1.2	12.61	11.33

Variables having no superscript in the same row are not significantly different (p>0.05)
SD: Standard deviation, DMY: Dry matter yield

stalk which was lower (p>0.05) than all other treatments but similar with that of iron coating. In case of corn ears, iron coating decreased (p<0.05)significantly height of ears than that of other treatments except monocrop corn treatment. However, iron coating enhanced height of soybean plant which was higher (p>0.05) than that of thiram coating but remained similar (p>0.05) with control treatment. In case of corn sole(Positive control), corn stalk height, corn ear height, corn stalk number, corn ear number was 271.6 cm, 94.0 cm, 40740 no./ha, 41666 no./ha, respectively.

3. Effect of soybean seed coating on dry matter yield of forage

The soybean seed coatings didn't influence (p>0.05) dry matter yield in corn stalks, corn ears and soybean. Whereas, dry matter yield in corn stalk, ear and total corn was 5.62 ton/ha, 4.60 ton/ha, 10.23 ton/ha respectively under corn sole (Positive control).

4. Effect of soybean seed coating on nutritive value of forage

Soybean seed coating didn't affect (p>0.05) total digestible nutrients (TDN) yield in corn, soybean and total mixed forage as elaborated in Table 4. TheTDN yield in corn stalk, ear and total corn was 5.62 ton/ha, 4.60 ton/ha, 10.23 ton/ha under corn sole (Positive control treatment).

Ⅳ. DISCUSSION

Findings of present study depicted that pre-sowing activity of soybean seed coating with thiram improved survivability of soybean seedlings against wild bird's damage but didn't alter yield performance of corn soybean intercropping forage. These observations were also ascertained previously that pre-sowing seed treatment with fungicidal chemical containing thiram might favor only in establishment of soybean without having influence on crop yield (Brzezinski *et al*., 2015) but improved soybean seedling growth andfield emergence (Usha and Malakiva, 2014). The wild birds voided effectively thiram coated soybean seeds in comparison to non-coated seeds under a simulated diversification of food sources (Lopez-Antia *et al*., 2014). The possible reason might be adequate repellency of thiram against birds (Sandhu *et al*., 1987; Avery and Decker, 1991) and its sedative effect on activity of central nervous

Table 4. Effect of different soybean seed coatings on total digestible nutrient yield in corn soybean mixed forage (Mean ± SD)

Parameters	Corn with no soybean coating (Control)	Corn with iron coated soybean	Corn with thiram coated soybean
Corn TDN yield(ton/ha)	8.02 ± 0.9	8.02	7.32
Soybean TDN yield (kg/ha)	441 ± 0.1	428	364
Total TDN yield(ton/ha)	**8.46 ± 0.9**	8.44	7.68

Variables having no superscript in the same row are not significantly different (p>0.05)

system in wild birds (Avery *et al*., 1995).

After establishment of crop, it was found in present study that thiram had adverse effects on corn stalk and soybean plant heights which was also endorsed (Bays *et al*. 2007)that high concentrated thiram coating might hampered normal development of soybean seedlings. This adverse effect might be attributed to the inhibitory effect of thiram on rhizobial nodulation gene in thiram treated soybean seeds (Andres *et al*., 1998)and consequently thiram containing fungicidal chemicals might reduce nodulation and soybean plants growth (Pereira *et al*., 2009).

In-spite of low survivability after wild bird's damage in this study, pre-sowing seed coating with iron improved soybean plant's height in comparison to that of thiram coating treatment and maintained forage yield comparable to that of control treatment. Improvement in growth of soybean plant was also affirmed (Baglou *et al*. 2010)while investigating effect of nano-iron oxide particles on soybean. Higher soybean plant growth in iron coating might beattributed to significant increase in chlorophyll and nodules index due to pre-sowing seed treatment with zero-valent iron (Ngo *et al.*, 2014).

Ⅴ. CONCLUSION

It is concluded from findings that soybean seed coatings didn't influence yield andnutritive value of corn soybean intercropping forage.

Ⅵ. ACKNOWLEDGEMENTS

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