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GENETICALLY DISTINCT CULTIVAR HYBRIDS FOR THE TREATMENT OF INSECT PESTS AND INCREASED AGRICULTURAL PRODUCTIVITY

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ABSTRACT

Modern farming enables the easy migration of insect pests and illnesses from plant to plant, devastating cropping regions. According to the resistance and the theory of the adversary, increasing diversity of plants lowers quantity of plagues and damage. The growing diversity of plant species may improve the management of insects through bottom-up and top-down mechanisms, based on considerable study. Despite this support, logistical and financial constraints have precluded broad adoption of pesticide management and techniques for diversification of output. Intraspecific genetic diversity has been shown in both fundamental and practical research to enhance ecosystem stability and function. Planting cultivar mixtures may be a more viable way of enhancing genotypical variety of plants. Our aim is to combine data supporting intraspecific variation in order to achieve a viable pest management strategy for field insect pests. We have found important evidence that genotypical variety improved the fitness and productivity of plants in both wild and agricultural settings. Intra-specific variation may, according to many lines of research, assist to improve insect pest control. Empirical data or practical techniques of application in agricultural systems are seldom found. Limited usage of this method, therefore. Intraspecific varieties of plants enhance plant performance by decreasing pest population and promoting niche division. Further research is required to reduce the use of pesticides and increase production. Intraspecific crop diversity with low costs or changes to production may be introduced. Intraspecific diversity has been a popular and sustainable management approach because of the benefits of biodiversity for yield stability.

KEYWORDS: *Agriculture, Cultivar, Genotypical, IPM, Pest Management.*

1. INTRODUCTION

Many integrated pest management (IPM) academics and practitioners have aimed at developing sustainable management programmes that are more robust and less dependent on synthetic pesticides. Agricultural systems typically concentrate on sustainable insect pest management programmes utilizing crop types that are more tolerant to or resistant to pest attacks and methods to agriculture which enhance their natural enemies' efficacy in reducing pest populations. Various plant species combinations have been investigated, whether in agricultural fields or adjacent non-crop regions, in order to enhance both their impacts on bottom up and top down in crop fields. However, while there is potential to enhance the control of plagues, pest management techniques based on harnessing the diversity of plants, such as non-crop plants at field boundaries or intercrops within fields, are not commonly used by conventional farmers in developed countries because the mechanical production is costly, time consuming or logistically challenging. Given these constraints, an IPM strategy must be developed which increases the variety and the structural complexity of agro-ecosystems, but which does not demand exceptional changes in agricultural or monetary investment practices on the part of farmers[1].

An emerging corpus of natural system literature has shown that genotypic variety may play a significant part in the structure and fitness of arthropod populations. Fewer study has been done in agricultural environments to demonstrate, despite claims made to the contrary, the impact of intraspecific variation on pest control. However, many lines of research indicate that increasing genotypical variety in agricultural fields may significantly enhance the management of insect pests and crop outcomes in an economically and ecologically sustainable way. Our aim was to examine the literature on natural and agricultural systems within the framework of a conceptual framework which shows the many ways under which plant growth and output may improve on intraspecific or genotypical variation. We define 'genotypic diversity' as genetic variance across species variations and regard 'genetic diversity' as a population assessment of variation or associations within a variety. Although both words are interchangeable, we concentrate on the former[2].

1.1 Background:

In the United States and globally, the vast majority of agricultural fields are planted with single genetic variants. In the past, every plant in a field is almost genetically the same as its neighbor. These cultivars feature consistent agricultural characteristics, such as height, germination, period of development, seeds and protein content, so as to simplify agriculture logistics and optimize output. However, low genetic variability is a responsibility which leaves agricultural fields susceptible to insect invasion and breakdown. If all plants in a field are vulnerable to the same plague species, the plague populations expand quickly, once they enter a field. For example, when insect pests like the Mayetiola destructor hessian fly Say defeat resistant cultivars, agricultural fields may rapidly be devastated. In other instances, just one insect or disease may be resisted or resisted by the plants. The greatest crop production is thus obtained with frequent use of pesticide, which has detrimental impacts on non-target species and human and environmental health. To decrease the intensity of pests and insecticides, alternatives to single species/genotype planting are necessary[3].

As well as being less resistant to pest attacks, monotypic plant fields are particularly prone to spoilage due to a lack of natural enemies and biological control services. In general, monocrops are less natural enemies than polycrops (or crops in non-crop plants), where the outbreaks of pests are rare. A shortage of overwintering sites implies that every year natural enemies have to invade agricultural fields to give pests a head start. In addition, agricultural areas are frequently poorly settled by natural enemies due to the absence of food from plants and prey, and other resources, such as suitable microclimates and oviposition. In addition, artificial selection for certain features has affected tritrophic interactions in some plant species, such that natural enemies cannot contribute to herbivorous control of agricultural variety as effectively as in the case of wild cousins. In conclusion, management activities such as the usage, cultivation and harvesting of pesticides further disrupt natural adverse populations in agricultural fields[4].

1.2 Associate Diversity:

A great deal of study has focused on the advantages of plant variety and its impact on insect diversity and herbivorous control. Our objective is not to examine this amount of research, but we will emphasize a few points on the advantages and difficulties of plant variety and the management of plagues. Firstly, species mixes or polycultures may adversely affect arthropod pests by limiting their capacity to search for preferred host plants, which means that they cannot simply migrate from host to host, delaying their propagation across agricultural areas. Second, increasing diversity in either cropland, adjacent crop areas or regional improvements through landscape scales can also enhance top-down control by providing floral resources, alternative prey and suitable microclimates to enhance enemy natural fitness, abundance, diversity and spring habitat. Third, despite the advantage of substantial pest control associated with some of the diversification methods, efficacy seems to be uneven and context-dependent. Fourthly, it should be noted that growing variety of plant species frequently involves significant logistical and/or economic difficulties. For example, producing more than one crop in one single field is not feasible with current agricultural equipment and diversification via non-crop areas may cut down on productive acreage. For example, with dubious economic advantages and considerable difficulties, farmers seldom adopt methods to enhance plant variety for better pest management[5].

1.3 Benefits of Genotypical Diversity:

A method to enhancing variety in agricultural systems that is more feasible and encouraged is to enhance genotypical diversity of plants within species. This strategy goes against large-scale monotypic crops dominating agriculture. But fundamental evolutionary theory implies that intra-specific variation is of tremendous importance. After all, genetic diversity is the foundation of natural selection and, without this selection, populations risk extinction since they cannot withstand the range of problems they encounter in their environment. In addition, it is evident that a lack of genetic diversity may lead to certain undesirable populations-level occurrences, such as inbreeding and bottlenecks. Maybe it is thus not unexpected that a growing corpus of empirical research in both animals and plants show the benefit of greater intraspecific variety.

For years, it has been known that intra-specific variety offers flexibility for populations in a number of situations to thrive. However, a recent collection of research has shown that genotypical diversity has an emerging impact on system productivity and resilience. Colonies formed by multiplying Queens of honeybees, for example, are much more productive than colonies produced by single-paired queens (more waggle dances, higher rates of drinking, foragers using further food sources). Similar autotrophic effects were observed. Genotypically different mixes of the Chlamydo-reindhartiiDangeard algae grew 10% higher than genetic monocultures of the same species in laboratory experiments. The pots planted with Arabidopsis thaliana (L.) genetic mixes were 17 percent more prolific than the monocultures under semi-natural circumstances. Boosted levels of intraspecific variation in field plots have also increased production of Solidagoaltissima L's above-ground biomass by 36%. In these instances of higher plant production, geno-typically diverse plants may use more of the available resources than monocults, possibly owing to the complementarity of varieties. Importantly, recent study has shown that genotype diversity's impact on primary output may be comparable to that of plant variety. The mechanism(s) underlying comparable effects of plant species and genotypic diversity are yet to be understood, although arthropods seem to be one of the contributing elements[6].

In addition, genotypically different groups are known to withstand diseases better. This is because a wider variety of genotypes in different populations will have decreased infections susceptibility. Diseases will therefore not spread so readily throughout the community. This enhanced disease resistance has been shown experimentally for a variety of species, including vertebrates (e.g. frogs), invertebrates (e.g. honeybees), and plants (e.g. willow).

A growing literature also shows that intrinsic variety in natural plant systems may have a significant impact on arthropod populations and herbivory, frequently spreading to plant production. Similar to the impacts of plant diversity, genotypical variety plays a significant role in structuring insect populations and generating many trophic level environmental interactions. In fact, some of the work has even led to conclusions that 'plant genotype can be one of the most important ecological factors in the formation of tritrophic groups' and that plant genotypic diverse influences arthropod communities, including natural enemy species, mostly in relation to soil microbes, fungi and the plants. For example, a genotypically diverse seedling of willow has suffered up to 50 percent less leaf beetles damage than willow monocultures as beetles are preferably grown in patches of more appropriate hosts (e.g. hypothesis for resource concentration) and have difficulty finding palatable willow varieties when grown in mixtures.

Likewise, two US-born plant species study has shown that genotypic plant variety may also lead to fewer herbivories, albeit via another method. In such instances, the increasing phenotypic variety linked to rising levels of genotypic diversity has improved the diversity of arthropods, particularly those of natural enemies that restrict herbivorous insect populations, leading to increased production of superficial biomass. Genotypic variation may significantly influence the quantity and conduct of the natural enemy. These effects are often caused by phenotypic variety which follows genotypic variation and may affect the number of natural enemies even in the case of identical herbivore populations. Examples of genotypic variety encourage huge populations of insect herbivores. Caterpillars that fed on Arabidopsis genotypically different plants produced a total biomass 19% higher than monoculture-grown caterpillars. Although it has not been clearly examined the mechanism driving high caterpillar biomass, a combination of food products with different nutritional quality may enhance caterpillar development rates. Similarly, several S. altissima plots enhanced the growth rate for the aphid population in comparison to monotypical plots. In this research, aphids migrated from highly populated, fewer resistant genotypes to less populated and more resistant genotypes where population growth may rise, thereby contributing to the findings among other processes of aphid migration between high and low-competitive hosts.

Research has shown that increasing genotypical variety in plant communities improves resilience to abiotic stress and stochastic events like higher temperatures or disturbances, along with bottom up and top down impacts on herbivorous abundance or plant health. Eelgrass biomass, for example, rose by as much as 30 percent in the face of severe temperatures, while planting variety expanded from one to six genotypes. This indicates that, in the face of abiotic stress, more genotypically varied populations may retain their production rather than monoculture. Genetically different populations may also rebound from perturbation more rapidly, such as vertebrate pasture, and even better withstand invasion. In this latter instance, weed biomass was 32 percent lower in S. altissimageno-types, as a result of a combination of genotype diversity and identity effects, than in monotypical plots. This data indicates that genotypically varied populations may be more stable and robust to increasing stress, as anticipated under many global climate change scenarios[7].

The different data shows strongly that increasing genotypical variety in a broad range of systems may improve productivity and resilience. While there is still much to learn about the role of genotypical diversity in ecological interactions and ecosystem functions, the current evidence is particularly attractive for agriculture, as productivity, herbivorous resistance and resistance to abiotic stress are essential features of sustainable crop production. In addition, genotypical diversity may be introduced with very modest modifications in farming technique. If the theoretical and empirical findings continue to confirm the significant impact of genotypical variety on plant production, a simple new approach to agriculture may revolutionize planting and agricultural productivity methods.

1.4 Treatment of Diseases:

Monoculture has been created to optimize the potential for development of better genotypes and genetic uniformity (e.g. seedling, maturity) is related to harvesting and processing, but genetic uniformity is also disadvantaged by the uniform susceptibility to pests. Uniformity-related vulnerability may be reduced by increasing the number of cultivars in fields in order to enhance genotypical variation. The resultant 'cultivar mixes' are described as mixtures of genotypes "which differ for various characteristics, including illnesses, yet have adequate resilience to growing together." "Cultivar mixtures" Almost 50% of Europe's wheat fields and tens of thousands of hectares of China's rice are cultivar mixes. In the USA, 18% of soft winter wheat planted in the state of Washington in 2000 and 7% of Kansas planted in 2001 were cultivar mixes. Typically, these blends are random blends of five cultivars that are susceptible to significant illnesses and produce over 30 per cent better than monocultures when disease occurs while yield is maintained, or even slightly improved when the disease is absent. Most importantly, mixture-related logistics, in especially in tiny grains where cultivar mixes were most popular, did not impede output[8].

1.5 Other Advantages of Agroecosystem Genotypical Diversity:

In order to enhance output and other agronomic advantages, additional ecological mechanisms are being developed in genotypically diverse plants, as well as arthropod and disease control. Increased levels of genotypic variety may lead to increased floral abundance and greater diversity and quantity of floral visitors, which might lead to increased genotypical diversity. Similar to plant communities with abundant species, geno-typically diversified plants are abler to withstand invasions by other plant species. The types of wheat vary considerably in their fight against weeds and mixing varieties with different competitive capabilities may substantially enhance weed removal and production[9].

Genetically varied fields tend to provide modest but substantial improvements in production as a consequence of intergenotypic light, soil and water interactions. This yield advantage was calculated at 5·4% and 11% correspondingly for wheat and soybeans. This impact is due partly to the complementarity of farmers, which means that the mixture as a whole is able to utilize resources in the field better since cultivars operate slightly different microniches in direct competition, because of distinct processes. Some wheat combinations were also more productive under low organic circumstances. Some oat combinations have yields up to 9 percent in the face of drought stress, indicating that genotypic diversity may contribute to buffer agriculture against climate change extremes[10].

Another significant advantage from cultivar mixes is the consistency of output, which enables farmers to better anticipate their yearly production and to minimize risk. Due to numerous biotic and abiotic variables, a specific monoculture may or may not be the highest performing variety, but these factors are likely to be changed next year. A crop mix reduces this yearly uncertainty because stability comes from complementing variations in crops that tend to balance. The impacts of biodiversity on 'portfolio' or 'insurance' may therefore stabilize agricultural yields in various biotic and abiotic situations.

2. DISCUSSION

It offers tremendous potential for improving disease resistance, decreasing insect abundance, and increasing crop production in agricultural fields by increasing the variety of genotypes within a field. Due to the over-reliance on synthetic pesticides, the development of resistance has triggered a vicious cycle of resistance that is unsustainable and laden with ramifications that include deterioration of human and ecological health. As a result, farmers need alternative pest control methods to preserve their crops and earnings while also reducing their dependence on pesticides. Consumer demand for agricultural goods produced more responsibly with little or no pesticide residue has also resulted in the fast expansion of the organic crop industry, which now includes crops grown for human and animal use. These farmers have few choices for pest control, and cultivar combinations would be very beneficial to them if they were planted.

When looking at things from an evolutionary standpoint, planting fields with more than one type of seed makes sense since mixed fields would be less susceptible to environmental disturbance, whether it is caused by humans or by nature. As a result, varied cultivar combinations are a popular and successful method of managing diseases in wheat, rice, and other crops throughout Europe, Asia, and a few areas of the United States. Research from natural systems also shows that insect herbivore populations may be significantly affected by intraspecific plant variety, which is consistent with previous findings. We now need to do applied research to see whether or not these many lines of evidence may lead to better insect pest management via the use of cultivar combinations. The following conceptual framework, which is based on interactions seen in some of the material examined here, is provided to assist in directing this research: a conceptual framework Interactions among plants, herbivores, and natural enemies that are anticipated to be affected by genotypic diversity are presented in the framework, as are some of the processes that may be driving these interactions. In order to encourage hypothesis-driven research into how these relationships affect insect pest management in agricultural systems, the following vision is presented: These interactions, as shown in at least one crop species and a sea grass, may also serve to protect agricultural systems against abiotic extremes such as those anticipated to be imposed by climate change.

Efficacy of intraspecific crop variety as an insect control strategy is being investigated at all levels of the research process, from fundamental ecology through farmer application. Examples include determining the number of cultivars that provide the most yield while maintaining the highest level of stability, as well as determining if this number can be used across crop species and management methods (e.g. organic vs. conventional). Also required is investigation into how various pests and natural enemies react to intraspecific variation, as well as whether guilds of pests, such as aphids, behave in a comparable manner to one other. Due to the fact that the majority of natural-systems research has been conducted in very small plots, conducting large-scale experiments in field crops would not only be necessary to determine efficacy for growers, but it would also greatly advance our understanding of how intraspecific diversity affects the food web and trophic dynamics.

This research is particularly important since combining resistant and non-resistant varieties in the same field should prevent the development of resistance to resistant kinds (i.e. improve durability of resistance; Gould 1986a). This technique is credited with helping to reduce resistance to transgenic Bt crops in part because it involves planting susceptible varieties alongside insect-resistant Bt types to provide a safe haven for Bt-susceptible pests throughout the growing season. Because plant resistance characteristics are often among the only weapons available for controlling certain pest species, research is required to define levels of resistance to insect herbivores in different crop species, as well as to discover novel forms of resistance. New resistant types may then be created and integrated into cultivar mixes, which will aid in the preservation of the effectiveness and durability of such instruments.

3.CONCLUSION

Many advantages appear to be gained from cultivar mixtures. As long as the agronomic characteristics of the varieties are similar, farmers should not be required to alter production practices such as planting and harvesting times, nor should they be required to make any financial investments in new equipment. Important because logistical and economic considerations are the main impediment to the adoption of innovative, environmentally friendly pest-farming methods in the first place. Using cultivar mixes does not seem to provide significant economic or logistical difficulties, and in fact, it may have positive effects on both the economy and output. Growers have a high possibility of reducing insect issues while maintaining or even boosting yields if they strategically increase genotypic variety. Such environmentally friendly pest control methods should be further investigated.

REFERENCES

1. I. M. Grettenberger and J. F. Tooker, “Moving beyond resistance management toward an expanded role for seed mixtures in agriculture,” *Agriculture, Ecosystems and Environment*. 2015, doi: 10.1016/j.agee.2015.04.019.

2. L. B. Chanu, G. K. N. Chhetry, and G. D. Sharma, “Sustainable Indigenous Practices for the Management of Pest and Diseases of Upland Rice in Manipur, North East India,” *Assam Univ. J. Sci. Technol. Biol. Environ. Sci.*, 2010.

3. J. F. Tooker and S. D. Frank, “Genotypically diverse cultivar mixtures for insect pest management and increased crop yields,” *Journal of Applied Ecology*. 2012, doi: 10.1111/j.1365-2664.2012.02173.x.

4. A. V. Shoffner and J. F. Tooker, “The potential of genotypically diverse cultivar mixtures to moderate aphid populations in wheat (Triticum aestivum L.),” *Arthropod. Plant. Interact.*, 2013, doi: 10.1007/s11829-012-9226-z.

5. M. Lazzaro, A. Costanzo, and P. Bàrberi, “Single vs multiple agroecosystem services provided by common wheat cultivar mixtures: Weed suppression, grain yield and quality,” *F. Crop. Res.*, 2018, doi: 10.1016/j.fcr.2017.10.006.

6. A. Kirmer, A. Baasch, and S. Tischew, “Sowing of low and high diversity seed mixtures in ecological restoration of surface mined-land,” *Appl. Veg. Sci.*, 2012, doi: 10.1111/j.1654-109X.2011.01156.x.

7. K. Mody, J. Collatz, A. Bucharova, and S. Dorn, “Crop cultivar affects performance of herbivore enemies and may trigger enhanced pest control by coaction of different parasitoid species,” *Agric. Ecosyst. Environ.*, 2017, doi: 10.1016/j.agee.2017.05.009.

8. R. Machida-Hirano, “Diversity of potato genetic resources,” *Breeding Science*. 2015, doi: 10.1270/jsbbs.65.26.

9. M. J. Arturi, M. B. Aulicino, O. Ansín, G. Gallinger, and R. Signorio, “Combining Ability in Mixtures of Prairie Grass and Clovers,” *Am. J. Plant Sci.*, 2012, doi: 10.4236/ajps.2012.310163.

10. A. R. Szumigalski and R. C. Van Acker, “The agronomic value of annual plant diversity in crop-weed systems,” *Can. J. Plant Sci.*, 2006, doi: 10.4141/P05-074.