

# Research on Camouflage Performance of Hanging Plants

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**Abstract**—In the engineering practice of camouflage, which is located under the background of mountain forest land national defense engineering needs to disguise. A kind of effective method to deal with the optical band infrared and radar reconnaissance is needed. In the forest background, vegetation is a common background characteristics. Construction of national defense fortifications can produce obvious signs, using camouflage net screen time consuming is difficult. Sustained and effective time is short. And the green economy of low cost, obtains the way is simple, short training period, and the camouflage effect is good, and the difference of target and background is smaller. In addition, there is a good camouflage properties of the infrared and radar band. This topic is proposed by planting test, hanging plant growth in the cultivation of observation and performance study of disguise, to look forward to designing to simulate forest background characteristics of hanging plants. Optimizing a few short-term effects, good effect of grass seed, through the continuous experiment of different variables, we design the best group of plant. The optimum combination of variables is studied for plant camouflage provides a new way of thinking.

**Keywords**—camouflage performance; hanging plants; design; camouflage effect

## I. INTRODUCTION

With modern reconnaissance technology and the rapid development of the weapon system, detection means is varied, the probability of traditional defense engineering is found to significantly increase. How to adopt a more effective way to reduce the probability that important defense project goals are found. It is worth our research. The national defense is mainly of the engineering background. National defense engineering slope and elevation of concrete structure under the condition of the optical radar and infrared surveillance, are easy to expose the target. To improve the national defense engineering field survival ability, it must carry on the effective disguise.

In recent years, the vegetation for the related research at home and abroad has obtained some achievements. If it applies to the national defense project should have good effects in disguise. Compared with the traditional method of camouflage, plant method has obvious advantages in disguise. Cultivating the preparation of large hanging plants, camouflage surface of defense projects. For the purpose of taking to restore terrain landform slope, plants camouflage should possess good camouflage effect. Plant has a good shelter disguise conveniently, and the advantages of low cost. When the plant reaches a certain density on the surface of the national defense

engineering, it can effectively cope with optical detection of infrared and radar reconnaissance equipment. To improve the defense engineering field survival ability is of great significance.

## II. PLANT CAMOUFLAGE OVERVIEW

Traditional plant camouflage is to use the disguise seeding transplant and acquisition of plant cover or cover target method of camouflage. Camouflage is mainly plant cover, plant screen (vertical screen plant, plant cover screen and deformation screen) on plants and plants discoloration and other methods. Plant cover screen is with tall grass trees constitute a plant in an area where the configuration or forest is hidden goal against the ground and aerial reconnaissance of new plants and natural plant consist of a new area. and it makes the target is located in the number of plants on only one side of flora the number of the wood should be huge, its target is located in some of the same groups. When the target area is larger, the canopy which couldn't cover all parts should be on the top of the target exposed planting shrubs Herbs or set box plants [1].

It can be applied to the top and fortifications on both sides of the overlying soil willing to pay in front and back wall and the top of the cover slag discharge soil surface and the exposed surface because of destruction of the vegetation construction area. There are mainly laying turf Methods such as sowing the seeds of shrub or vine crop should be paid attention to when working for select shovel turf or transplant plant site and camouflage project should have a certain distance, at the same time works at the top or on the surface of the soil may not be significantly higher than the surrounding plants, prevent to produce new signs [2].

Plant deformation screen is targeted as the plant change shape and the shadow of a kind of camouflage methods, which is usually used in the target area is large, special shape and the absence of time. The method is to grow above target in the side of the goal of trees, or the target set box plants.

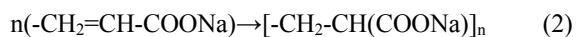
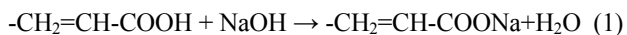
## III. HANGING PLANTS DESIGN THINKING

This topic mainly choose the ryegrass, white clover, Green-turf grass, turnspit dog, bermuda grass five green grass short feet to experiment, the first cycle will study plant absorption layer species as variables, and then optimizing water absorption layer of light conditions in the second cycle experiment recorded within the period of plant growth, optical and infrared

photographs taken. Plants were analyzed the percentage of the optical image of the green pixels, and camouflage performance analysis, the final design hanging plate plants to save all experimental data into database

Water absorption layer variable experiment chose vermiculite and polymer resin material. Vermiculite is a natural non-toxic mineral, expands in high temperature under the action of mineral It is a very rare mineral, belongs to the silicate. Its crystal structure is monoclinic system. From the appearance, it looks like mica. Vermiculite is a granite hydration. It is generally produced in conjunction with asbestos. Because of vermiculite has the ability to ion exchange, it is of great effect on soil nutrition. Agriculture, vermiculite can be used as a soil conditioner, due to its good cation exchange and adsorption, it can improve soil structure, water keep moisture, improve soil permeability and aqosity, make it become a neutral soil from acidic soil. Vermiculite can also play a buffer action, hinder the rapid change of PH value, and make slow release fertilizer on crop growth medium, and allow a little too much use of fertilizers which do not have a harm to the plant. Vermiculite can also be provided to crop itself contains of Ca Fe Mg K and trace Mn Cu Zn and other elements. The Cation exchange and water imbibition of vermiculite and the chemical composition characteristics, make it play a protecting fertilizer water reservoir permeability and mineral fertilizer etc multiple effect. Experiment showed that zero point five percent to one percent of expanded vermiculite mixed with compound fertilizer, it can make the crop yield increase by fifteen percent to twenty percent. Gardening, vermiculite can be used for fruits and vegetables planting seedling flowers etc. Except as potting soil and regulator are also used in soilless culture. As planting potted tree and commercial seedbed of nutrition at the grass-roots level, particularly is valuable for plant transplanting and shipping. Vermiculite can effectively promote the growth of plant roots and the stable development of seedlings for a long time to provide needed to make plants grow moisture and nutrition, and can maintain the stability of the root sunshine temperature. Vermiculite can make the crop from the early stages of growth can get enough water and minerals, promotes faster plant growth, increases production. Super Absorbent Polymer (SAP) is a kind of typical functional polymer materials. It can absorb hundreds of times its own weight Even thousands of times more water and have a strong water retention, so it is also known as super SAP or high water retention agent [3].

SAP Water absorption principle is as follows.



sodium polyacrylate  $\rightarrow$  The bridge into the network structure, where internal ion concentration is higher than external due to the osmotic pressure. SAP has cubic element bridge, inhibits the phenomenon of expansion, which has a high absorbent resin absorbent.

#### IV. GRASS IN EXPERIMENTAL

For small sample plots, expected 20 days, trial scheme is as follow, which is shown in Figure 1.

- a. Use pot planting grass, each specification one hundred square centimeters, of soil formation, seed evenly spread.
- b. Weighing grass seed, according to 25 grams per square meter, 0.25g each experimental basin grass seed quality.
- c. To grow and the observation of maintenance, evening each watering every day in the morning a record growth temperature.

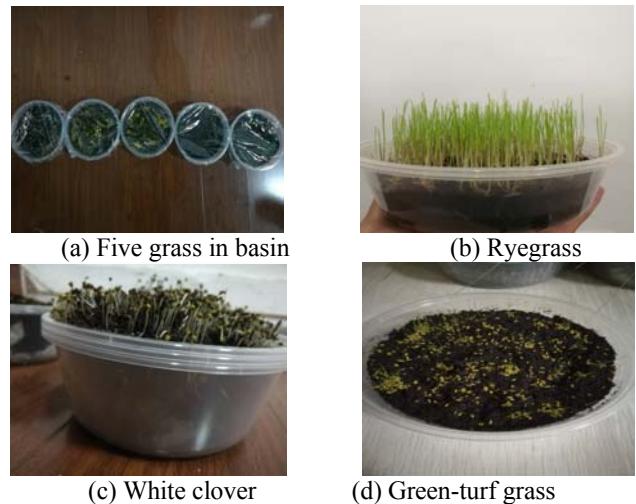


FIGURE 1. PLANTING TRIAL

#### V. EXPERIMENT RESULTS

- a. Ryegrass, Green-turf grass two grass germination rate is high, the grass planting day 3 can sprout, grow fast, young growth period covered the performance in general, at later growth cover stage performance is good.
- b. Turnspit dog, bermuda grass low germination rate, slower growth, the growth of young period covered the performance in general, cover at later growth stage performance is good.
- c. White clover germination rate is high, the seeded third day can sprout, grow fast, young growth period covering performance good, covering performance is very good at later growth stage (Growth reference Table 1 and Figure 2).

Through the analysis of experimental data, we get the following conclusion:

- a. Making use of hanging plants in plant should be rapid growth, strong stress resistance, cover of high rate of planting. Tests shows that the plant ryegrass, White clover grow best, can in a relatively short period of time to achieve high cover rate, meet the needs of the camouflage
- b. Defense projects to achieve permanent camouflage will ensure the grass in the experiments of full seasons. Test has a cold and warm type two kinds, the perennial ryegrass, White

clover all match for the cold season, with warm type grass bermuda grass realizes the grass type covering full seasons

c. Turnspit dog in mixed seeding experiments, poor growth, poor compatibility with some other plants, So, it is not suitable for use [4].

TABLE I. TRIALS ARE PLANT GROWTH RECORD (UNIT:CM)

| species | ryegrass | white clover | Green-turf grass | turnspit dog | bermuda grass |
|---------|----------|--------------|------------------|--------------|---------------|
| 3 days  | 0        | 0.5          | 0                | 0            | 0             |
| 6 days  | 5        | 1.2          | 0                | 0            | 0             |
| 9 days  | 9        | 3.1          | 0.9              | 0            | 0             |
| 12 days | 14       | 4.3          | 1.2              | 0            | 0             |
| 15 days | 17       | 5.5          | 5.4              | 0            | 0             |
| 20 days | 21       | 6.3          | 7.1              | 0.3          | 0.2           |

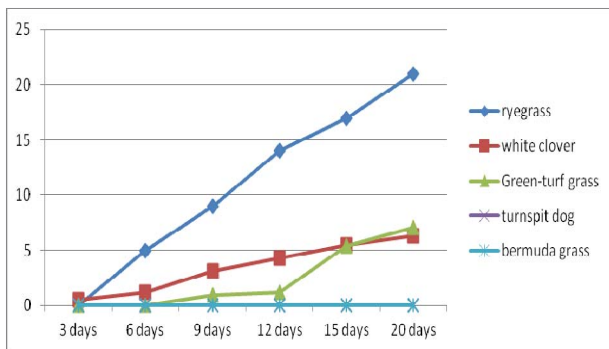


FIGURE II. PLANT GROWTH LINE CHART

VI. HANGING THE CAMOUFLAGE PERFORMANCE STUDY OF PLANTS

Camouflage with reconnaissance is a pair of contradictions. They both are independent of each other, fight with each other and influence each other. With promoting each other with the injection rapidly, the military target threat more and more seriously. Disguise as a counter reconnaissance means of monitoring the most economic and effective, the position is becoming more and more significant in the modern war. For now, the modern reconnaissance not only realizes the spatial three-dimensional reconnaissance, day and time, Round-the-clock surveillance, and realizes the full band from optical microwave to infrared surveillance. Reconnaissance found and recognition ability is greatly increased. So the single infrared and optical anti-radar camouflage technology and method cannot have satisfied the need of modern military frontier, camouflage. Technology must develop fusion to multispectral compatible Multi-function with the direction of development

Hanging plants in study of this subject is a part of fusion camouflage technology content, so in order to fully test the camouflage performance of hanging plants from two aspects of optical properties and infrared characteristics to testing the camouflage properties of plants.

Due to the optical detection is based on the goal and background at optical wavelengths reflection performance differences between implementation by using optical reconnaissance. So for hanging plants optical performance in color, brightness, rough surface state, background texture, etc

are consistent with the corresponding woodland background. Through the optical camera photography and visual observation of optical performance to detection and compared with the background, which is shown in Figure 3.



FIGURE III. OPTICAL IMAGE OF DIFFERENCE DISTANCE

Circumstances in the woodland, the green vegetation coverage rate of no less than seventy percent, hanging plants green vegetation coverage is above ninety percent, they can well realize the goal and background on color coordinated. According to the shape and habit of similar background of plant species selection of plant, species can be a very good meet the target and the background on the roughness of the surface requirements; Through the observation, 20 days of perennial ryegrass and 40 days of perennial ryegrass has differences in color depth, in terms of forest land background now, forty days ryegrass in optics and the background is better. Anyhow, hanging plants in terms of optical camouflage can well satisfy the need of woodland area defense project camouflage.

Characteristics of temperature and emissivity of target and background determines the infrared radiation characteristics of target background. Infrared detection equipment is using the infrared radiation characteristics of the differences between them from the background found that identify the target object temperature characteristic is not only related to their own nature of the object, also influenced by external conditions, the biggest impact of the external factors are due to solar radiation and target surface absorbs the sun's energy can make the temperature rising rapidly, which is shown in Figure 4. The differences in different times due to solar radiation heat will form different target maps [5].

So hanging plants characteristics of infrared detection, including the use of radiation thermometer measures the degree of ecological pot of grass and the background and the use of infrared imaging testing samples and the background of the infrared heat maps, which is shown in Figure 4, 5 and 6.

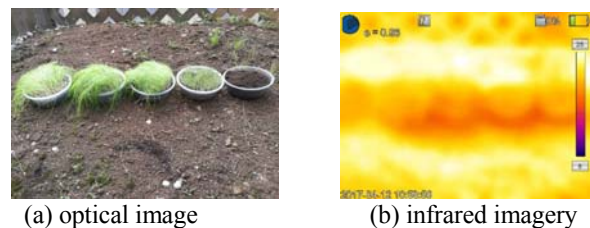


FIGURE IV. PERENNIAL RYEGRASS 20 DAYS, MEAN TEMPERATURE 20.4.C



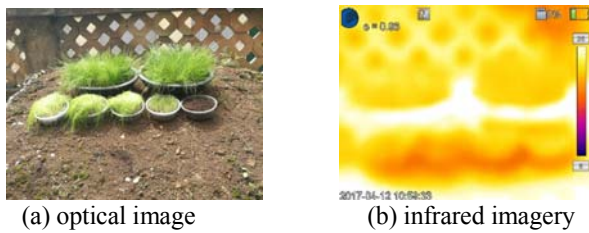


FIGURE 5. 20 AND 40 DAYS RYEGRASS CONTRAST, MEAN TEMPERATURE 19.8.C

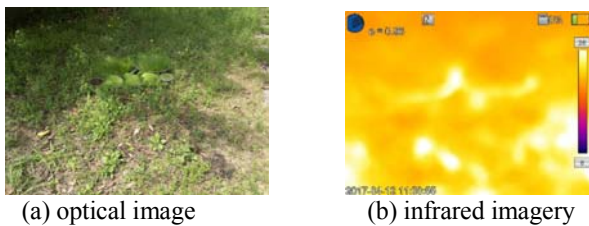


FIGURE 6. RYEGRASS SAMPLES COMPARED WITH FOREST BACKGROUND HEAT MAP, MEAN TEMPERATURE 20.1.C

Through the above three kinds of infrared heat map analysis, shown in Figure 4, 5 and 6, 20 days of perennial ryegrass infrared heat map and soil heat difference is smaller, the background of the forty days ryegrass surface temperature is lower, and has a certain gap with the background. Through optical images were compared with the infrared heat maps, as for how, in the actual application to specific situation analysis.

## VII. CONCLUSIONS

According to the topic of the goal, to complete the task significance hanging the grass seed selection is carried out. Through 20 days of trial, which suited the climate growth of perennial ryegrass and white clover are selected. Then, carrying on variable researches with the plant growth factors, water absorbing, layer growth, through the data comparison, using optimization absorbent layer to do illumination experiments. Designing the testing camouflage properties of the wall hanging plants scheme, optical and infrared camouflage performance research, we know, for perennial ryegrass varieties, 20 days and 40 days of optical and infrared camouflage effect is not the same, and need to in reference to the experiment data on the concrete analysis of the situation. This experiment is a certain amount of research results have been achieved, but slightly rough, on camouflage effect evaluation needs a scientific and reasonable complete evaluation system and model, which is to a direction in the future.

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